

**Liquid crystal transfer body and method of manufacturing the same****Publication number:** CN1406341 (A)**Publication date:** 2003-03-26**Inventor(s):** MASANORI UMEYA [JP]; KEIJI KASHIMA [JP]; HIDEO FUJIMURA [JP]**Applicant(s):** DAINIPPON PRINTING CO LTD [JP]**Classification:**

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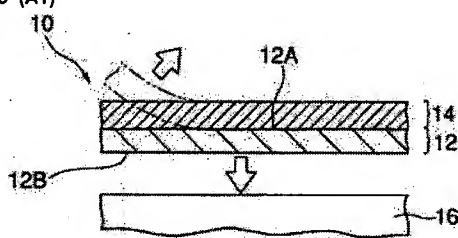
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A liquid crystalline transfer sheet 10 includes a liquid crystal layer 12 formed on the surface of a substrate 14, where the surface hardness of the liquid crystal layer 12 is higher on the releasing surface 12A side, which is on the substrate 14 side, than on the adhering surface 12B side, which is on the receiving object 16 side. Therefore, the adhesion between the adhering surface 12B of the liquid crystal layer 12 and the receiving object 16 becomes stronger than that between the releasing surface 12A of the liquid crystal layer 12 and the substrate 14. It is thus possible to securely transfer the liquid crystal layer 12 to the receiving object 16 without leaving a part of the liquid crystal layer 12 on the substrate 14.



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# **LIQUID CRYSTAL TRANSFER BODY AND METHOD OF MANUFACTURING THE SAME**

## **Field of Invention**

The present invention relates to a liquid crystal transfer body capable of transferring a  
5 liquid crystal layer with a polarization effect and other optical effects to a transferred body,  
and more particularly to a liquid crystal transfer body and a method of manufacturing the  
same, capable of releasing the liquid crystal layer formed on a surface of a support body  
from the support body and transferring the liquid crystal layer to the transferred body.

## **Background of the Invention**

10 In conventional art, in the liquid crystal transfer body, a release layer or an  
easily-adhesive layer is disposed between a liquid crystal layer and a support body, such  
that the liquid crystal layer is easily released from the support body, and then transferred to  
a transferred body.

Here, in order to transfer the liquid crystal layer to the transferred body, the liquid  
15 crystal layer must be adhered to the transferred body. For the conventional method, usually  
an adhesive layer is disposed as a medium between the liquid crystal layer and the  
transferred body to which the liquid crystal layer is transferred. Further, in addition to  
predisposing the adhesive layer on a transferring surface (a side adhered to the transferred  
body) side of the liquid crystal layer or a transferred body side, the transferring surface of  
20 the liquid crystal layer is disposed during the process of transferring the liquid crystal layer  
to the transferred body, or the adhesive layer is disposed on the transferred body.

Further, the liquid crystal layer may be adhered to the transferred body by, for example,  
hot pressing.

However, as described above, for the liquid crystal transfer body having the release  
25 layer or the easily-adhesive layer disposed between the liquid crystal layer and the support

body, the structure becomes complicated because of the multiple layers. Further, the materials of the release layer or the easily-adhesive layer are mixed in the liquid crystal layer, so during releasing, a part of the material may be adhered to the liquid crystal layer, such that the optical characteristics of the liquid crystal layer after being transferred to the transferred body are deteriorated.

Moreover, in the above liquid crystal transfer body, the liquid crystal layer is adhered to the transferred body by using the adhesive layer as the medium, and the optical characteristics of the liquid crystal layer after being transferred to the transferred body are deteriorated due to the adhesive layer. The reason of the deterioration of the optical characteristics under the situation is, for example, an interface reflection occurring on an interface between the adhesive layer and the liquid crystal layer and between the adhesive layer and the transferred body. Further, because of the flowability of the adhesive layer, during the process of transferring the liquid crystal layer to an extremely flat transferred body, the thickness becomes nonuniform due to the flow of the adhesive layer, and thus the flatness of the adhered liquid crystal layer is lowered.

Furthermore, it is difficult to manufacture the adhesive layer to be a thin layer with a thickness less than 1  $\mu\text{m}$ . Because of the thickness, chromaticity change, release, and discoloration because of heating as described in Japanese Patent Publication Heisei 8-313729, Japanese Patent Publication Heisei 11-29325, Japanese Patent Publication Heisei 8-75924, and Japanese Patent Publication Heisei 11-151877 etc mostly occur. Particularly, as described in Japanese Patent Publication 2000-28827, under a situation that the adhesive layer is composed of acrylic resin, it is already known that the discoloration is resulted when the temperature is higher than 200°C.

More particularly, in the above liquid crystal transfer body, even the liquid crystal layer is adhered to the transferred body by hot pressing, under the situation without the release layer, the easily-adhesive layer, and the adhesive layer, after the liquid crystal layer and the support body are closely adhered to the transferred body by hot pressing, it is difficult to release the liquid crystal layer from the support body.

Here, because of the materials of the support body and the transferred body, a close-fitting force between the transferred liquid crystal layer and the support body is larger than the close-fitting force between the liquid crystal layer and the transferred body. Under this situation, after the liquid crystal layer is transferred to the transferred body, it is difficult to release the liquid crystal layer from the support body. Particularly, under the situation that the liquid crystal layer is quite thin, the liquid crystal layer may be broken during the release. Further, as described in Japanese Patent Publication Heisei 11-311710, other cholesteric liquid crystal layer is hot-pressed on the cholesteric liquid crystal layer, but even so, the cholesteric liquid crystal layer is still quite thin. As compared with the close-fitting force between the cholesteric liquid crystal layers, the close-fitting force between the cholesteric liquid crystal layer and the support body is larger, such that it is difficult to transfer the cholesteric liquid crystal layer to the transferred body, and the cholesteric liquid crystal layer may be broken (be damaged).

### **SUMMARY OF THE INVENTION**

In view of the above, the present invention is directed to a liquid crystal transfer body and a method of manufacturing the same, capable of surely and easily transferring a liquid crystal layer to a transferred body under a situation of not damaging the liquid crystal layer without using a release layer, an easily-adhesive layer, or an adhesive layer.

In a first characteristic of the present invention, a liquid crystal transfer body is provided. The liquid crystal transfer body has a support body, and a liquid crystal layer formed on a surface of the support body, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side. A surface hardness of the liquid crystal layer near the adhesive surface is lower than that of the liquid crystal layer near the release surface.

In the liquid crystal transfer body according to the first characteristic of the present invention, the liquid crystal layer is composed of polymerizable liquid crystal molecules, and preferably, a residual double bond index of the liquid crystal molecules of the liquid

crystal layer near the adhesive surface is higher than that of the liquid crystal molecules of the liquid crystal layer near the release surface. Further, in the liquid crystal layer, preferably, the residual double bond index of the liquid crystal molecules near the release surface is lower than 60% of that of the liquid crystal molecules of the liquid crystal layer near the adhesive surface.

In the liquid crystal transfer body according to the first characteristic of the present invention, preferably the liquid crystal layer is composed of a plurality of thin liquid crystal layers laminated in sequence. Further, each thin liquid crystal layer is composed of polymerizable liquid crystal molecules, and preferably, in the plurality of thin liquid crystal layers, the residual double bond index of the liquid crystal molecules near the adhesive surface is higher than that of the liquid crystal molecules of the thin liquid crystal layers near the release surface. Further, preferably, the residual double bond index of the liquid crystal molecules of the thin liquid crystal layer forming the release surface is lower than 60% of that of the liquid crystal molecules of the thin liquid crystal layer forming the adhesive surface.

In the liquid crystal transfer body according to the first characteristic of the present invention, preferably the liquid crystal molecules of the liquid crystal layer are of cholesteric phase. Further, preferably the support body is a stretch film. Further, in the support body, preferably, an alignment film is formed on a surface of the support body in contact with the release surface of the liquid crystal layer.

In a second characteristic of the present invention, a method of manufacturing a liquid crystal transfer body is provided. The liquid crystal transfer body includes a support body, and a liquid crystal layer formed on a surface of the support body, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side. The method includes forming the liquid crystal layer composed of liquid crystal molecules polymerized by a ray irradiation on the surface of the support body, and curing the liquid crystal layer by the ray irradiation under an air atmosphere, such that a surface hardness of the liquid crystal layer

near the adhesive surface is lower than that of the liquid crystal layer near the release surface.

5 In the liquid crystal transfer body according to the second characteristic of the present invention, preferably, the air atmosphere is an atmosphere with an oxygen concentration above 0.5%.

10 In a third characteristic of the present invention, a method of manufacturing a liquid crystal transfer body is provided. The liquid crystal transfer body includes a support body, and a liquid crystal layer formed on a surface of the support body, composed of a plurality of thin liquid crystal layers, adhered to a transferred body through an adhesive surface  
15 located on an opposite side of the support body, and released from a release surface located on the support body side. The includes forming a thin liquid crystal layer composed of liquid crystal molecules polymerized by a ray irradiation on the surface of the support body, curing the thin liquid crystal layer by the ray irradiation, forming an additional thin liquid crystal layer composed of the liquid crystal molecules polymerized by the ray irradiation on  
20 the surface of the cured thin liquid crystal layer, and curing the additional thin liquid crystal layer by the ray irradiation. A desired number of the thin liquid crystal layers are laminated in sequence, the procedures of forming and curing the additional thin liquid crystal layer are repeated more than once, and a cured state of each thin liquid crystal layer is controlled such that in the liquid crystal layer composed of the plurality of thin liquid crystal layers, a  
hardness of the thin liquid crystal layer the adhesive surface is lower than that of the liquid crystal layer near the release surface.

25 In the liquid crystal transfer body according to the third characteristic of the present invention, preferably, the cured state of each thin liquid crystal layer is controlled by an oxygen concentration in an atmosphere when the ray irradiation is performed on each thin liquid crystal layer. Further, preferably, the cured state of each thin liquid crystal layer is controlled by an irradiation amount of a ray irradiated on each thin liquid crystal layer.

In a fourth characteristic of the present invention, a method of manufacturing a liquid

crystal transfer body is provided. The liquid crystal transfer body includes a support body, and a liquid crystal layer formed on a surface of the support body, composed of a plurality of thin liquid crystal layers, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side. The method includes laminating a desired number of the thin liquid crystal layers composed of liquid crystal molecules polymerized by an ultraviolet (UV) irradiation in sequence on the surface of the support body, and curing the thin liquid crystal layers by the UV irradiation lamination. In the liquid crystal layer composed of the plurality of thin liquid crystal layers, a hardness of the thin liquid crystal layer near the adhesive surface is lower than that of the liquid crystal layer near the release surface, and a cured state of each thin liquid crystal layer is controlled by an amount of a photo initiator added into each thin liquid crystal layer.

According to the present invention, the surface hardness of the liquid crystal layer near the release surface located on the support body side and the surface hardness of the liquid crystal layer near the adhesive surface located on the transferred body side are adjusted. An adhesive force between the adhesive surface of the liquid crystal layer and the transferred body is larger than that between the release surface and the support body, so when the liquid crystal layer is closely adhered to the transferred body, the support body may be easily released from the liquid crystal layer. Therefore, even without using the release layer, the easily-adhesive layer, or the adhesive layer, the liquid crystal layer is surely easily transferred to the transferred body without damaging the liquid crystal layer to leave a part thereof on the support body.

Further, according to the present invention, the layer composition is quite simple as no release layer or easily-adhesive layer is disposed between the liquid crystal layer and the support body of the liquid crystal transfer body. The materials of the release layer or the easily-adhesive layer are mixed in the liquid crystal layer, and thus a part of the material will not be adhered to the liquid crystal layer during the release.

In addition, according to the present invention, no adhesive layer is disposed between

the liquid crystal layer of the liquid crystal transfer body and the transferred body as a medium, and thus the number of interfaces is reduced, such that the deterioration of the optical characteristics of the liquid crystal layer resulting from the interface reflection will not occur. The liquid crystal layer is directly adhered to the transferred body, even under  
5 the situation that the transferred body has a high flatness, the flatness may be maintained without deteriorating the optical characteristics. Furthermore, problems such as the chromaticity change, release, and discoloration because of heating resulting from the adhesive layer are avoided.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

10 The present invention will become more fully understood from the detailed description given herein below for illustration only, and thus are not limitative of the present invention, and wherein:

FIG. 1 is an enlarged schematic cross-sectional view of a liquid crystal transfer body according to a first implementation of the present invention;

15 FIG. 2 is a schematic cross-sectional view of a method of manufacturing the liquid crystal transfer body as shown in FIG. 1;

FIG. 3 is an enlarged schematic cross-sectional view of a liquid crystal transfer body according to a second implementation of the present invention;

20 FIG. 4 is a schematic cross-sectional view of the method of manufacturing the liquid crystal transfer body as shown in FIG. 3;

FIG. 5 is a schematic cross-sectional view of another method of manufacturing the liquid crystal transfer body as shown in FIG. 3;

25 FIG. 6 is a curve of logarithmic decrement vs. temperature of a surface of the liquid crystal transfer body adhered to the transferred body according to an embodiment of the present invention; and



FIG. 7 is a curve of logarithmic decrement vs. temperature of the surface of the liquid crystal transfer body adhered to the transferred body according to a comparison of the present invention.

## **DETAILED DESCRIPTION OF THE INVENTION**

5        Implementations of the present invention are described with reference to the accompanying drawings.

### First Implementation

Firstly, the first implementation of the present invention is described with reference to FIGs. 1 and 2.

10        As shown in FIG. 1, in a liquid crystal transfer body 10 according to the first implementation of the present invention, a liquid crystal layer 12 is formed on a surface of a support body 14 composed of, for example, a stretch polyethylene terephthalate (PET) film. Here, the liquid crystal layer 12 may be adhered to a transferred body 16 through an adhesive surface 12B located on an opposite side of the support body 14, and may be  
15 released from a release surface 12A located on the support body 14 side. Further, a surface hardness of the liquid crystal layer 12 near the release surface 12A located on the support body 14 side is higher than that of the liquid crystal layer 12 near the adhesive surface 12B located on the transferred body 16 side.

The liquid crystal layer 12 is formed by photo-polymerization liquid crystal (for  
20 example , cholesteric liquid crystal) aligned after contacting with the support body 14 composed of the stretch PET film. As described as follows, by adjusting the curing condition, the surface hardness near the release surface 12A side and the surface hardness near the adhesive surface 12B side are made to be different as described above. Further, in addition to liquid crystal molecules (liquid crystal monomers or liquid crystal oligomers)  
25 polymerized by an UV irradiation and the like, the liquid crystal layer 12 may use polymer liquid crystals.

Further, the so-called “liquid crystal layer” refers to the film with the liquid crystal property (particularly the optical characteristics) part instead of the liquid crystal phase in physical meaning. For example, even without the flowability, a cured film with a liquid crystal phase (for example, cholesteric phase) molecular arrangement is a liquid crystal layer described herein.

Next, referring to FIG. 2, a method of manufacturing the liquid crystal transfer body 10 as shown in FIG. 1, that is, the method of making the surface hardness of the liquid crystal layer 12 near the release surface 12A side different from that of the liquid crystal layer 12 near the adhesive surface 12B side, is described. Here, for example, the liquid crystal layer 12 is formed by the cholesteric liquid crystal monomers polymerized by the UV irradiation.

A cholesteric liquid crystal monomer solution with a photo-polymerization initiator is prepared, and is coated on the surface of the support body 14 composed of the stretch PET film as shown by a numeral 11 in FIG. 2(A). A solvent of the solution is removed by drying, so as to form an uncured liquid crystal layer 11A as shown in FIG. 2(B).

Next, as shown in FIG. 2(B), under the air atmosphere (with an oxygen concentration of approximately 20%), an UV irradiation is performed on the uncured liquid crystal layer 11A and the support body 14 from the liquid crystal layer 11A side, so as to cure the liquid crystal layer 11A. In this manner, as shown in FIG. 2(C), the liquid crystal transfer body 10 having the cured liquid crystal layer 12 may be manufactured.

Here, the adhesive surface 12B side of the liquid crystal layer 12 is exposed in the air, the UV irradiation restrains the break of a C=C bond of the liquid crystal molecule (such as the double bond between carbon atoms in propenyl of the cholesteric liquid crystal molecule), and the release surface 12A side is cured without contacting with the oxygen. Therefore, the surface hardness of the liquid crystal layer 12 near the adhesive surface 12B becomes lower than that of the liquid crystal layer 12 near the release surface 12A.

Therefore, as shown in FIG. 1, when the liquid crystal layer 12 is transferred to the transferred body 16, a close-fitting force between the adhesive surface 12B of the liquid

crystal layer 12 and the transferred body 16 is larger than the close-fitting force between the release surface 12A and the support body 14, the liquid crystal layer 12 is adhered to the transferred body 16, and it is easy to release the liquid crystal layer 12 from the support body 14.

- 5        Here, the surface hardness (surface cure degree) of the liquid crystal layer 12 may be determined by a residual double bond index of the liquid crystal molecules near the release surface 12A and the adhesive surface 12B. The so-called “liquid crystal molecule” refers to unimolecule, oligomer, polymer, and liquid crystal compound with the reactive C=C bond.

Further, the so-called “residual double bond index” is defined as:

- 10        [Spectral intensity absorbed by the C=C bond (near  $810\text{ cm}^{-1}$ ) in the liquid crystal molecule]/[Spectral intensity absorbed by aromatic ring (near  $1500\text{ cm}^{-1}$ ) in the liquid crystal molecule]

- The residual double bond index defined in this manner directly represents the proportion of the double bonds (C=C) which are not reacted in the polymerization reaction, so the reaction ratio (polymerization ratio) is represented by [(1-(residual double bond index))].
- 15

- Further, as described above, the surface hardness of the liquid crystal layer 12 near the adhesive surface 12B is lower than that of the liquid crystal layer 12 near the release surface 12A, such that the residual double bond index of the liquid crystal molecules of the liquid crystal layer 12 near the adhesive surface 12B is higher than that of the liquid crystal molecules of the liquid crystal layer 12 near the release surface 12A. Further, when the residual double bond index of the liquid crystal molecules is used for representation, for the ratio of the surface hardness of the liquid crystal layer 12 near the release surface 12A and that of the liquid crystal layer 12 near the adhesive surface 12B, preferably, the residual double bond index near the release surface 12A side is lower than 60% of the residual double bond index near the adhesive surface 12B side.
- 20
- 25

Further, under the situation of curing the liquid crystal layer 11A by the UV irradiation, if the oxygen concentration is too low, the reaction ratio difference between the release surface 12A side of the liquid crystal layer 12 and the adhesive surface 12B side may not be generated, so preferably, the oxygen concentration in the air atmosphere is above 0.5%.

5 Further, it is possible to change the UV to electronic rays for irradiation, but under this situation, preferably, the photo-polymerization initiator is not added into the cholesteric liquid crystal monomer solution coated on the surface of the support body 14.

In the liquid crystal transfer body 10 according to the first implementation of the present invention, the surface hardness of the liquid crystal layer 12 near the release surface 10 12A located on the support body 14 side and that of the liquid crystal layer 12 near the adhesive surface 12B located on the transferred body 16 side are adjusted, such that the adhesive force between the adhesive surface 12B of the liquid crystal layer 12 and the transferred body 16 is larger than the adhesive force between the release surface 12A and the support body 14. When the liquid crystal layer 12 is surely adhered to the transferred 15 body 16, it is easily to release the liquid crystal layer 12 from the support body 14. In this manner, even without using the release layer, the easily-adhesive layer, or the adhesive layer, the liquid crystal layer 12 may be easily transferred to the transferred body 16 without damaging the liquid crystal layer 12 to leave a part of the liquid crystal component of the liquid crystal layer 12 on the support body 14.

## 20 Second Implementation

A liquid crystal transfer body according to the second implementation of the present invention is described with reference to FIGs. 3 and 4. The liquid crystal transfer body according to the second implementation is approximately the same as that of the first implementation, except that the liquid crystal layer according the second implementation of 25 the present invention is composed of a plurality of thin liquid crystal layers. In the second implementation of the present invention, the parts identical to those in the first implementation are marked with the same numerals, and the detailed description thereof is

omitted.

As shown in FIG. 3, in a liquid crystal transfer body 20 according to the second implementation of the present invention, a liquid crystal layer 22 is formed on a surface of a support body 14 composed of, for example, a stretch polyethylene terephthalate (PET) film, and is composed of two layers (or more than three layers) of thin liquid crystal layers 24A and 24B laminated in sequence. Here, the liquid crystal layer 22 may be adhered to a transferred body 16 through an adhesive surface 22B located on an opposite side of the support body 14, and may be released from a release surface 22A located on the support body 14 side. Further, in the liquid crystal layer 22, a surface hardness of the thin liquid crystal layer 24A near the release surface 22A located on the support body 14 side is higher than that of the liquid crystal layer 24B near the adhesive surface 22B located on the transferred body 16 side. Further, the hardness ratio is the same as the situation in the liquid crystal layer 12 of the liquid crystal transfer body 10 according to the first implementation. When the thin liquid crystal layers 24A and 24B are composed of the polymerizable liquid crystal molecules, the hardness ratio is determined by the residual double bond index of the liquid crystal molecules of each thin liquid crystal layer 24A and 24B. For example, preferably, the residual double bond index of the liquid crystal molecules of the thin liquid crystal layer 24A near the release surface 22A side is lower than 60% of the residual double bond index of the liquid crystal molecules of the thin liquid crystal layer 24B near the adhesive surface 212B side.

Next, referring to FIG. 4, a method of manufacturing the liquid crystal transfer body 20 as shown in FIG. 3 is described. Here, for example, the liquid crystal layer 22 is formed by the cholesteric liquid crystal monomers polymerized by the UV irradiation.

A cholesteric liquid crystal monomer solution with a photo-polymerization initiator is prepared, and is coated on the surface of the support body 14 composed of the stretch PET film as shown by a numeral 21A in FIG. 4(A). A solvent of the solution is removed by drying, so as to form an uncured thin liquid crystal layer 23A as shown in FIG. 4(B).

Next, as shown in FIG. 4(B), under the nitrogen gas atmosphere (with an oxygen concentration lower than 0.5%), an UV irradiation is performed on the uncured thin liquid crystal layer 23A, so as to cure the thin liquid crystal layer 23A. In this manner, as shown in FIG. 4(C), a cured thin liquid crystal layer 24A is formed.

5        Then, as shown in FIG. 4(D), the cholesteric liquid crystal monomer solution the same as the above mentioned is coated on the surface of the cured thin liquid crystal layer 24A as represented by a numeral 21B, according to the same sequence, so as to form an uncured thin liquid crystal layer 23B as shown in FIG. 4(E).

10        Next, as shown in FIG. 4(E), under the air atmosphere (with an oxygen concentration above 0.5%), the UV irradiation is performed on the uncured thin liquid crystal layer 23B, so as to cure the thin liquid crystal layer 23B. In this manner, as shown in FIG. 4(C), a cured thin liquid crystal layer 24B is formed. Finally, the liquid crystal transfer body 20 with the liquid crystal layer 22 composed of the laminated thin liquid crystal layers 24A and 24B is thus manufactured.

15        Further, under the situation of more than three layers, the same procedures are repeatedly performed (FIGs. 4(D) to (F)), so as to laminate the desired number of the thin liquid crystal layers in sequence.

20        Here, the thin liquid crystal layer 24A is aligned through the alignment force of the support body 14 composed of the stretch PET film. On the other hand, the thin liquid crystal layer 24B is aligned by directly contacting with the thin liquid crystal layer 24A cured under the alignment state.

25        Further, as the thin liquid crystal layer 24B is cured under the air atmosphere, the cure degree thereof is lower than that of the thin liquid crystal layer 24A cured under the nitrogen gas atmosphere. That is, in the liquid crystal layer 22, the hardness of the thin liquid crystal layer 24A forming the release surface 22A releasing from on the support body 14 is higher than that of the liquid crystal layer 24B forming the adhesive surface 22B adhered to the transferred body 16. In this manner, the adhesive force between the thin

liquid crystal layer 24B and the transferred body 16 is larger than the adhesive force between the thin liquid crystal layer 24A and the support body 14.

Further, as described above, the cured states of the thin liquid crystal layers 24A and 24B may be controlled by the oxygen concentration in the atmosphere when the UV irradiation is performed on each thin liquid crystal layer 24A, 24B, and may also be controlled by an adding amount of the photo-polymerization initiator, an irradiation amount of the UV, or a combination thereof.

When the cured states of the thin liquid crystal layers 24A and 24B are controlled by the adding amount of the photo-polymerization initiator, as shown in FIG. 5, after the uncured thin liquid crystal layers 23A and 23B are pre-laminated in sequence (FIGs. 5(A) and (B)), the UV irradiation is performed on the laminated thin liquid crystal layers 23A and 23B once, so as to manufacture the liquid crystal transfer body 20 with the liquid crystal layer 22 composed of the laminated thin liquid crystal layers 24A and 24B.

When the cured states of the thin liquid crystal layers 24A and 24B are controlled by the oxygen concentration in the atmosphere, the irradiation amount of the UV and the like, the UV may be replaced by the electronic rays. Under this situation, the photo-polymerization initiator may not be added in the cholesteric liquid crystal monomer solution coated on the surface of the support body 14.

In the liquid crystal transfer body 20 according to the second implementation of the present invention, the hardness of the thin liquid crystal layer 24A forming the release surface 22A located on the support body 14 side and that of the thin liquid crystal layer 24B forming the adhesive surface 22B located on the transferred body 16 side in the liquid crystal layer 22 are adjusted, such that the adhesive force between the adhesive surface 22B of the liquid crystal layer 22 and the transferred body 16 is larger than the adhesive force between the release surface 22A and the support body 14. When the liquid crystal layer 22 composed of the thin liquid crystal layers 24A and 24B is surely adhered to the transferred body 16, the liquid crystal layer 22 may be easily released from the support body 14. In this

manner, even without using the release layer, the easily-adhesive layer, or the adhesive layer, the liquid crystal layer 22 may be easily transferred to the transferred body 16 without damaging the liquid crystal layer 22.

Further, in the first and the second implementations, the UV irradiation is performed on the liquid crystal layer formed on the surface of the support body 14 from the liquid crystal layer side, but the present invention is not limited thereto. When the UV passes through the support body 14 or little UV is absorbed, the irradiation may be performed by using the support body 14 as the medium. Under this situation, adjustments on, such as the thickness of the liquid crystal layer, the photo-polymerization initiator, the UV absorption of the liquid crystal, and the adding of the UV absorbing material when necessary, are performed, such that the ratio between the UV irradiation amount of the liquid crystal layer near the release surface side and that of the liquid crystal layer near the adhesive surface side is 10:6.

Further, in the first and the second implementations, the liquid crystal forming the liquid crystal layers 12 and 22 uses the cholesteric liquid crystal composed of the cholesteric phase liquid crystal molecules. However, the present invention is not limited thereto. The chiral nematic liquid crystal, the nematic liquid crystal, or any other liquid crystal may be used. Further, the support body 14 is not limited to the stretch film such as the stretch PET film, and other film substrates are also available. For example, when no alignment force exists on the surface of the substrate as the stretch PET film, an alignment film should be formed on a surface in contact with the release surfaces 12A and 22A of the liquid crystal layers 12 and 22.

Further, in the first and the second implementations, for example the liquid crystal layer is composed of the liquid crystal molecule (liquid crystal monomer and liquid crystal oligomer) polymerized by the UV irradiation. However, the present invention is not limited thereto. The liquid crystal layer composed of the polymer liquid crystal is also available. Under the situation of manufacturing the liquid crystal transfer body with the liquid crystal layer composed of the polymer liquid crystal, firstly, the polymer liquid crystal is coated on



the surface of the support body with the alignment force, after drying, the liquid crystal layer is formed. Next, a solvent is sprayed on the adhesive surface side of the liquid crystal layer, so as to increase the solvent concentration of the surface of the adhesive surface side to make it soft. Therefore, the liquid crystal transfer body, in which the surface hardness of the liquid crystal layer near the adhesive surface is smaller than that of the liquid crystal layer near the release surface, is manufactured.

## Embodiments

### (Embodiment 1)

Firstly, mix the nematic liquid crystal and a chiral agent, so as to prepare a 33% toluene solution of the cholesteric liquid crystal monomer (cholesteric liquid crystal solution) with a molecular spiral structure (cholesteric phase).

Next, add in the cholesteric liquid crystal solution 5% photo-polymerization initiator, for example Irg184, Irg369, or Irg651 (manufactured by Ciba Specialty Chemicals Group).

Then, coat the cholesteric liquid crystal solution on the surface of the stretch PET film serving as the support body and with a thickness of 50  $\mu\text{m}$  by spin coating, and dry within a temperature scope from normal temperature (21°C) to 80°C to remove the solvent of the solution, so as to form an uncured cholesteric liquid crystal layer with a thickness of 10  $\mu\text{m}$ .

Under the air atmosphere (with an oxygen concentration of approximately 20%) and a temperature under 21°C, a UV irradiation of 20  $\text{mJ}/\text{cm}^3$  is performed on the cholesteric liquid crystal layer and the support body from the cholesteric liquid crystal layer side, so as to cure the cholesteric liquid crystal layer. In this manner, the liquid crystal transfer body as shown in FIG. 1 is manufactured. An ultra-pressure mercury lamp is used as a light source of the UV irradiation, and the recorded UV intensity is the value tested by a 365 nm receiver.

The liquid crystal transfer body manufactured in this manner is adhered to the glass

serving as the transferred body through the adhesive surface located on the opposite side of the stretch PET film serving as the support body, and the hot pressing is performed by a laminating machine under a laminating condition of a roll temperature of 150°C, a speed of 0.5 m/min, and a roll pressure of 0.3 MPa.

5        Then, after being cooled to the normal temperature (21°C) by a heat release, it is easy to release the stretch PET film serving as the support body from the cholesteric liquid crystal layer, such that the cholesteric liquid crystal layer is surely transferred to the glass without damaging the cholesteric liquid crystal layer to leave a part thereof on the stretch PET film side.

10        (Embodiments 2 and 3)

The embodiments 2 and 3 share the same conditions with the embodiment 1, except that the thickness of the cholesteric liquid crystal layer is changed. In the embodiment 2, a liquid crystal transfer body with the cholesteric liquid crystal layer with a thickness of 1 μm is manufactured, and in embodiment 3, a liquid crystal transfer body with the cholesteric  
15        liquid crystal layer with a thickness of 5 μm is manufactured.

The liquid crystal transfer body manufactured in this manner and the glass serving as the transferred body are hot-pressed according to the same sequence as the embodiment 1, so as to transfer the cholesteric liquid crystal layer to the glass.

(Embodiment 4)

20        The cholesteric liquid crystal solution the same as that in the embodiment 1 is coated on the surface of the stretch PET film the same as that in the embodiment 1, so as to form an uncured cholesteric liquid crystal layer. Under a nitrogen gas atmosphere (with an oxygen concentration lower than 0.5%) and a temperature under 21°C, a UV irradiation of 10 mJ/cm<sup>3</sup> is performed from the uncured cholesteric liquid crystal layer side, so as to the  
25        cholesteric liquid crystal layer. In this manner, the first liquid crystal layer is formed.

Next, on the surface of the cured first thin liquid crystal layer, the same cholesteric liquid crystal layer is formed by direct filming according to the same sequence as the above. Under the nitrogen gas atmosphere (with the oxygen concentration lower than 0.5%) and the temperature under 21°C, a UV irradiation of 0.4 mJ/cm<sup>3</sup> is performed from the uncured cholesteric liquid crystal layer side, so as to cure the cholesteric liquid crystal layer. In this manner, the second liquid crystal layer is formed. Finally, the liquid crystal transfer body with the cholesteric liquid crystal layer composed of the laminated cured first and second thin liquid crystal layers is manufactured.

Here, the atmospheres when the UV irradiation is performed on the first and the second thin liquid crystal layers are the same, except that the irradiation amount of the UV on the first thin liquid crystal layer is more than 20 times of the irradiation amount of the UV on the second thin liquid crystal layer.

The liquid crystal transfer body manufactured in this manner and the glass are hot-pressed under the same laminating condition, and the liquid crystal transfer body is released from the stretch PET film after being cooled, such that the cholesteric liquid crystal layer is transferred to the glass without leaving a part of the first thin liquid crystal layer on the stretch PET film and without damaging the first or the second thin liquid crystal layer.

#### (Embodiment 5)

The cholesteric liquid crystal solution is coated on the glass serving as the transferred body, so as to form a cured cholesteric liquid crystal film. Then, each liquid crystal transfer body manufactured according to embodiments 1-4 and the glass with the cholesteric liquid crystal film are hot-pressed by the laminating machine in a manner of making the cholesteric liquid crystal layer of the liquid crystal transfer body contact with the cholesteric liquid crystal film of the glass, under a laminating condition of a roll temperature of 150°C, a speed of 0.5 m/min, and a roll pressure of 0.3 MPa.

Then, after being cooled to the normal temperature (21°C) by a heat release, release the

stretch PET film serving as the support body, in all the liquid crystal transfer bodies the stretch PET film is easily released from the cholesteric liquid crystal layer, such that the cholesteric liquid crystal layer is surely transferred to the glass with the cholesteric liquid crystal film serving as the transferred body.

## 5 (Comparison)

In order to compare with the liquid crystal transfer body manufactured according to the embodiment 1, the cholesteric liquid crystal solution the same as that in the embodiment 1 is coated on the surface of the stretch PET film the same as that in the embodiment 1, so as to form an uncured cholesteric liquid crystal layer. Under a nitrogen gas atmosphere (with an oxygen concentration lower than 0.5%) and a temperature under 21°C, a UV irradiation of 10 mJ/cm<sup>3</sup> is performed on the uncured cholesteric liquid crystal layer, so as to cure the cholesteric liquid crystal layer. In this manner, the liquid crystal layer as the comparison is formed.

The liquid crystal transfer body manufactured in this manner may not be entirely transferred to the glass under the laminating condition the same as that in the embodiment 1.

Further, Table 1 shows the results of the releasing intensity between the support body (stretch PET film) and the cholesteric liquid crystal layer and between the cholesteric liquid crystal layer and the glass of the embodiment 1 and the comparison tested at this time.

20 Table 1

Cholesteric liquid crystal transfer body	Releasing intensity of 10 <sup>-3</sup> N/mm	
	Between the support body and the cholesteric liquid crystal layer	Between the cholesteric liquid crystal layer and the glass
Embodiment 1	2	12
Comparison	2	2

It may be known from Table 1 that the releasing intensities of the liquid crystal transfer body of the comparison between the support body and the cholesteric liquid crystal layer and between the cholesteric liquid crystal layer and the glass are the same, but for the liquid crystal transfer body of the embodiment, the releasing intensities are different, the releasing intensity between the cholesteric liquid crystal layer and the glass is larger, that is, the cholesteric liquid crystal layer is hard to be released from the glass, and thus can be easily transferred to the glass side.

Table 2 shows tested results of the reaction ratio (polymerization ratio) of the liquid crystal molecules near the release surface and near the adhesive surface of the respective liquid crystal transfer body of the embodiment 1 and the comparison. The reaction ratio is proportional to the cure degree of the liquid crystal molecules near the release surface and near the adhesive surface of the cholesteric liquid crystal layer.

Table 2

Cholesteric liquid crystal transfer body	Embodiment 1		Comparison	
	Transfer side	Support body side	Transferred side	Support body side
Reaction ratio of the cholesteric liquid crystal molecules	1.6	2.7	2.6	2.6

In the test, the reaction ratio of the C=C bond within a scope of 2-3  $\mu\text{m}$  in the thickness direction of the tested surface of the cholesteric liquid crystal layer is determined through an infrared spectrum.

The cholesteric liquid crystal molecule has the propenyl, so under the UV irradiation, the C=C bond breaks for reaction, such that the liquid crystal layer is cured.

It may be known from Table 2 that, in the comparison, the reaction ratios (polymerization ratios) of the liquid crystal molecules near the release surface and near the adhesive surface of the liquid crystal transfer body are almost the same, but in the embodiment 1, the reaction ratio of the liquid crystal molecules near the adhesive surface is 59% of the reaction ratio of the liquid crystal molecules near the release surface.

Further, FIGs. 6 and 7 respectively show resolution results of the surface states of the surface (adhesive surface) of the liquid crystal transfer body adhered to the transferred body of the embodiment 1 and the comparison by using a rigid body vibrator tester (manufactured by A&D company).

FIGs. 6 and 7 show the relation between a logarithmic decrement and the temperature, which is one of the indices of the hardness of the tested surface. The higher logarithmic decrement results in the softer surface, and also results in the higher adhesion strength. It may be known from FIGs. 6 and 7 that as compared with that of the liquid crystal transfer body of the comparison 1, the close-fitting force between the liquid crystal transfer body of the embodiment 1 and the transferred body is larger, and residual double bond index of the liquid crystal molecules is larger.

Further, it may be known from the comparison between FIGs. 6 and 7 that, in the liquid crystal transfer body of the embodiment 1, the logarithmic decrement at the low temperature side is distinctly higher, which represents that even under the low temperature, and the surface of the cholesteric liquid crystal layer also has the flowing component. The flowability within a wide temperature range enables the deformation of the film easily be relieved when the cholesteric liquid crystal layer is transferred to the transferred body, so as to improve the adhesion strength. Here, the so-called flowing component refers to the uncured cholesteric liquid crystal molecules, the monomers, or the oligomers with a smaller molecular weight.

## CLAIMS

### What is claimed is:

1. A liquid crystal transfer body, comprising:  
  
a support body; and  
  
5 a liquid crystal layer, formed on a surface of the support body, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side, wherein a surface hardness of the liquid crystal layer near the adhesive surface side is lower than that of the liquid crystal layer near the release surface side.
- 10 2. The liquid crystal transfer body according to claim 1, wherein the liquid crystal layer is composed of polymerizable liquid crystal molecules, and a residual double bond index of the liquid crystal molecules of the liquid crystal layer near the adhesive surface is higher than that of the liquid crystal molecules of the liquid crystal layer near the release surface.
- 15 3. The liquid crystal transfer body according to claim 2, wherein the residual double bond index of the liquid crystal molecules of the liquid crystal layer near the release surface is lower than 60% of that of the liquid crystal molecules of the liquid crystal layer near the adhesive surface.
4. The liquid crystal transfer body according to claim 1, wherein the liquid crystal  
20 layer is composed of a plurality of thin liquid crystal layers laminated in sequence.
5. The liquid crystal transfer body according to claim 4, wherein each thin liquid crystal layer is composed of polymerizable liquid crystal molecules, and in the plurality of thin liquid crystal layers, a residual double bond index of the liquid crystal molecules in the thin liquid crystal layer near the adhesive surface is higher than that of the liquid crystal  
25 molecules of the thin liquid crystal layer near the release surface.

6. The liquid crystal transfer body according to claim 5, wherein the residual double bond index of the liquid crystal molecules of the thin liquid crystal layer forming the release surface is lower than 60% of that of the liquid crystal molecules of the thin liquid crystal layer forming the adhesive surface.

5        7. The liquid crystal transfer body according to any one of claims 1 to 6, wherein the liquid crystal molecules of the liquid crystal layer are of cholesteric phase.

8. The liquid crystal transfer body according to any one of claims 1 to 6, wherein the support body is a stretch film.

9. The liquid crystal transfer body according to any one of claims 1 to 6, wherein an alignment film is formed on a surface of the support body in contact with the release surface of the liquid crystal layer.

10. A method of manufacturing a liquid crystal transfer body, wherein the liquid crystal transfer body comprises a support body, and a liquid crystal layer formed on a surface of the support body, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side, the method comprising:

forming the liquid crystal layer composed of liquid crystal molecules polymerized by a ray irradiation on the surface of the support body; and

curing the liquid crystal layer by the ray irradiation under an air atmosphere, such that a surface hardness of the liquid crystal layer near the adhesive surface is lower than that of the liquid crystal layer near the release surface.

11. The method of manufacturing a liquid crystal transfer body according to claim 10, wherein the air atmosphere is an atmosphere with an oxygen concentration above 0.5%.

12. A method of manufacturing a liquid crystal transfer body, wherein the liquid crystal transfer body comprises a support body, and a liquid crystal layer formed on a



surface of the support body, composed of a plurality of thin liquid crystal layers, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side, the method comprising:

- 5           forming a thin liquid crystal layer composed of liquid crystal molecules polymerized by a ray irradiation on the surface of the support body;

          curing the thin liquid crystal layer by the ray irradiation;

- forming an additional thin liquid crystal layer composed of the liquid crystal molecules polymerized by the ray irradiation on the surface of the cured thin liquid crystal layer;
- 10

- curing the additional thin liquid crystal layer by the ray irradiation, wherein a desired number of the thin liquid crystal layers are laminated in sequence, the procedures of forming and curing the additional thin liquid crystal layer are repeated more than once, and a cured state of each thin liquid crystal layer is controlled, such that in the liquid crystal layer composed of the plurality of thin liquid crystal layers, a hardness of the thin liquid crystal layer near the adhesive surface is lower than that of the liquid crystal layer near the release surface.
- 15

13. The method of manufacturing a liquid crystal transfer body according to claim 12, wherein the cured state of each thin liquid crystal layer is controlled by an oxygen concentration in an atmosphere when the ray irradiation is performed on each thin liquid crystal layer.
- 20

14. The method of manufacturing a liquid crystal transfer body according to claim 12, wherein the cured state of each thin liquid crystal layer is controlled by an irradiation amount of the ray irradiated on each thin liquid crystal layer.

- 25           15. A method of manufacturing a liquid crystal transfer body, wherein the liquid

crystal transfer body comprises a support body, and a liquid crystal layer formed on a surface of the support body, composed of a plurality of thin liquid crystal layers, adhered to a transferred body through an adhesive surface located on an opposite side of the support body, and released from a release surface located on the support body side, the method comprising:

laminating a desired number of the thin liquid crystal layers composed of liquid crystal molecules polymerized by an ultraviolet (UV) irradiation in sequence on the surface of the support body;

curing the laminated thin liquid crystal layers by the UV irradiation lamination, wherein in the liquid crystal layer composed of the plurality of thin liquid crystal layers, a hardness of the thin liquid crystal layer near the adhesive surface is lower than that of the liquid crystal layer near the release surface, and a cured state of each thin liquid crystal layer is controlled by an amount of a photo initiator added into each thin liquid crystal layer.

## **ABSTRACT OF THE DISCLOSURE**

A liquid crystal transfer body 10 includes a liquid crystal layer 12 formed on a surface of a support body 14. A surface hardness of the liquid crystal layer 12 at a release surface 12A located on the support body 14 side is higher than that of the liquid crystal layer 12 at an adhesive surface 12B located on a transferred body 16 side. Therefore, an adhesive force  
5 between the adhesive surface 12B of the liquid crystal layer 12 and the transferred body 16 is larger than a close-fitting force between the release surface 12A and the support body 14, such that the liquid crystal layer 12 is surely transferred to the transferred body 16 without leaving a part thereof on the support body 14.

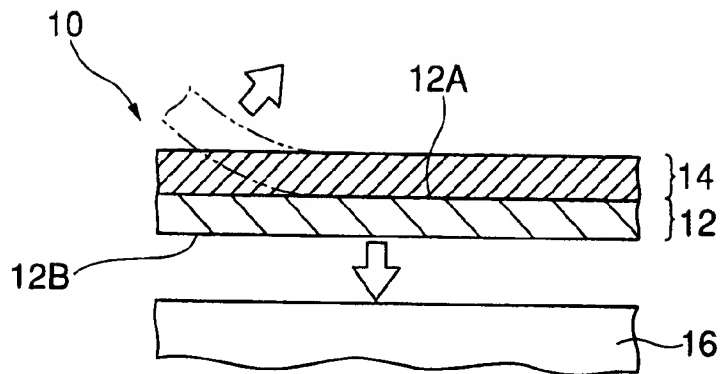


FIG. 1

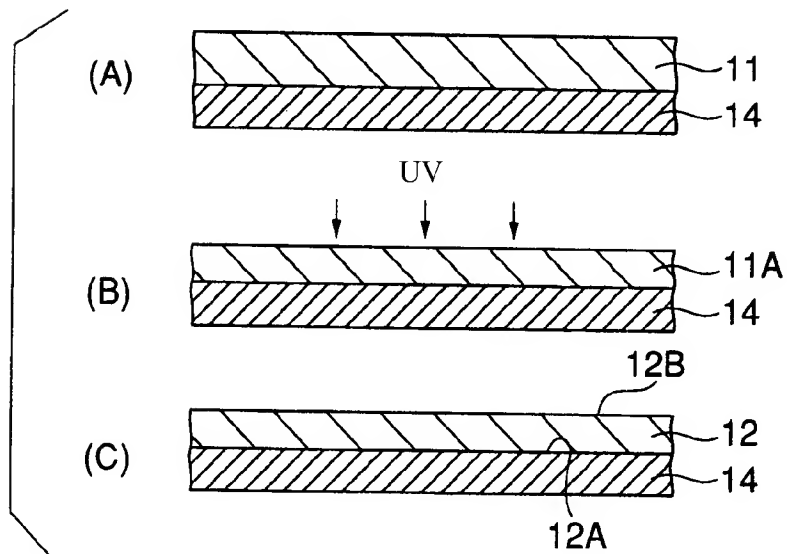


FIG. 2

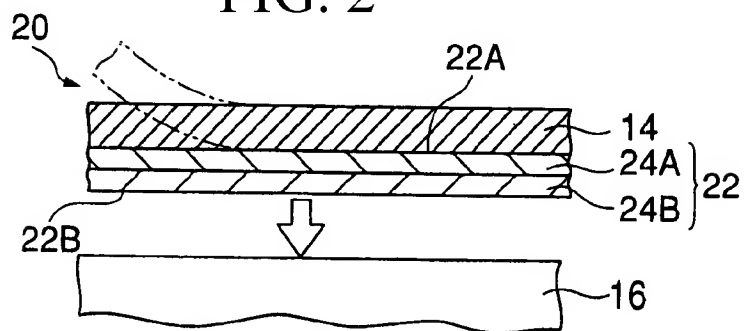


FIG. 3

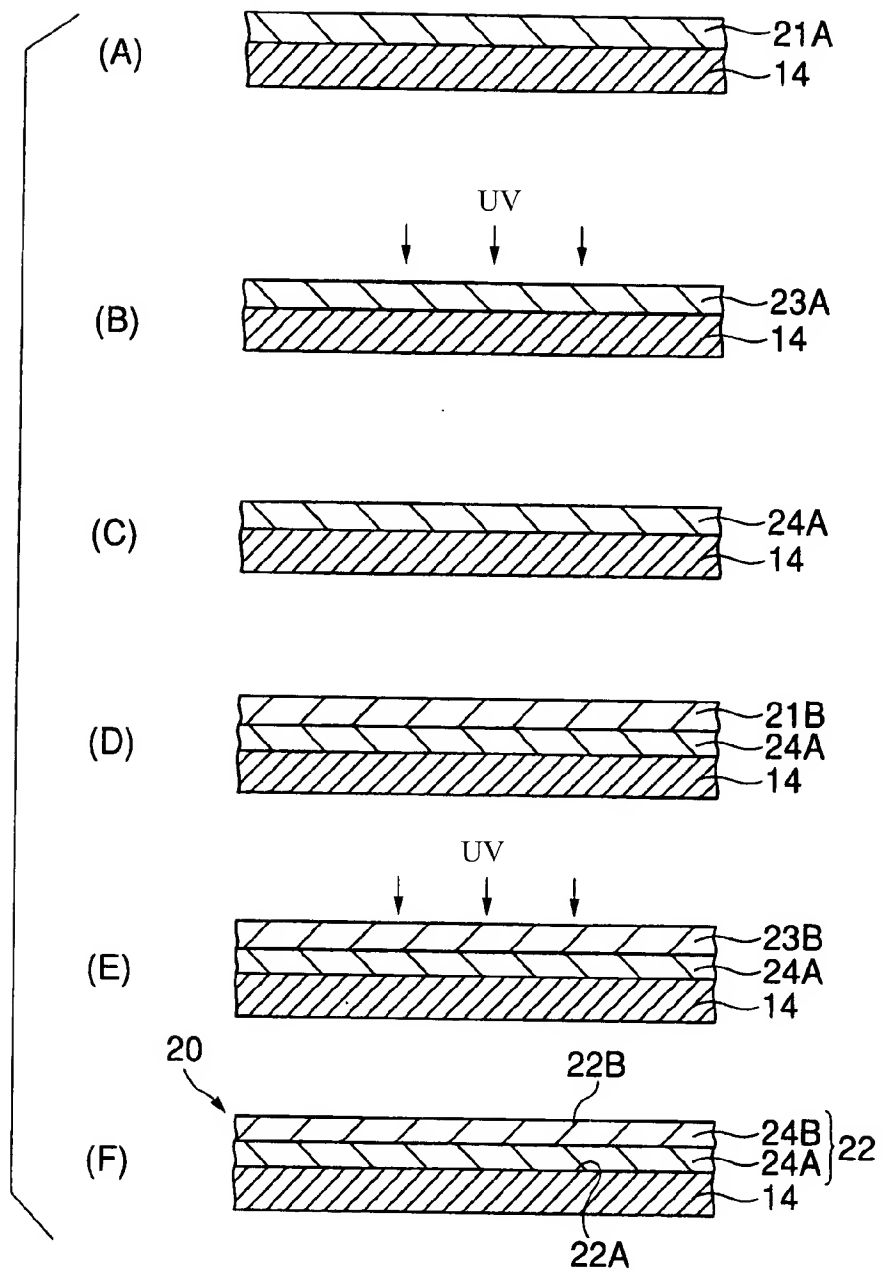


FIG. 4

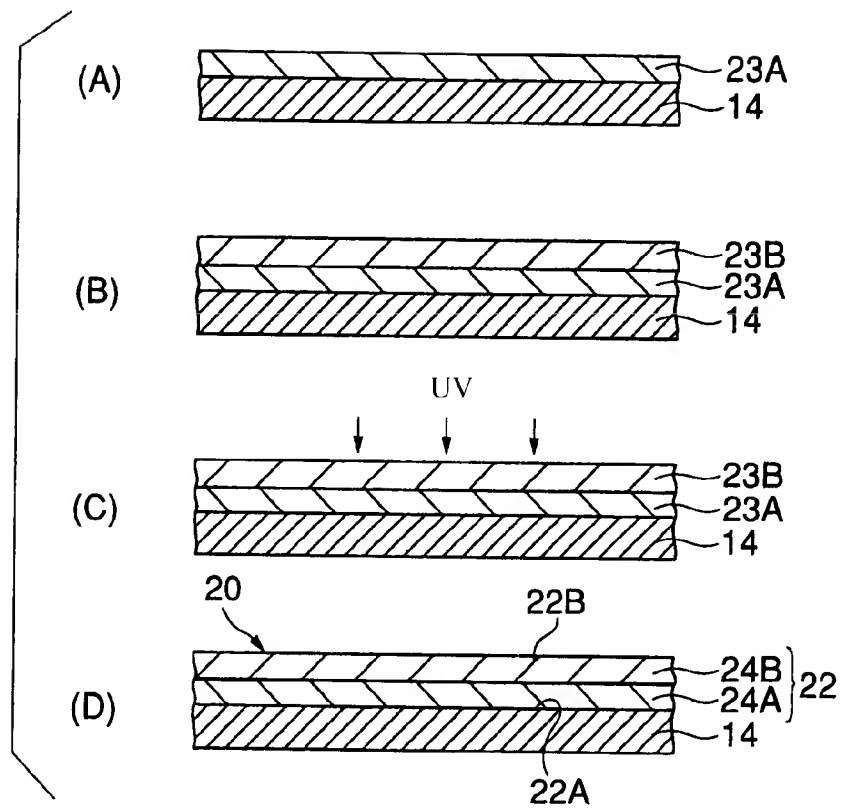


FIG. 5

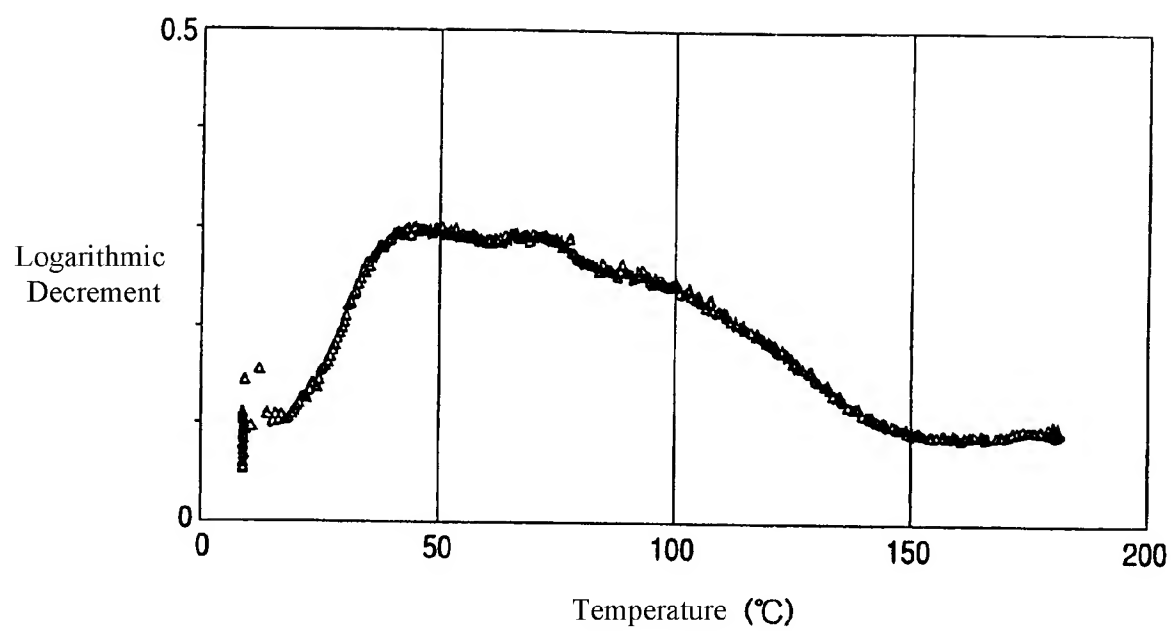


FIG. 6

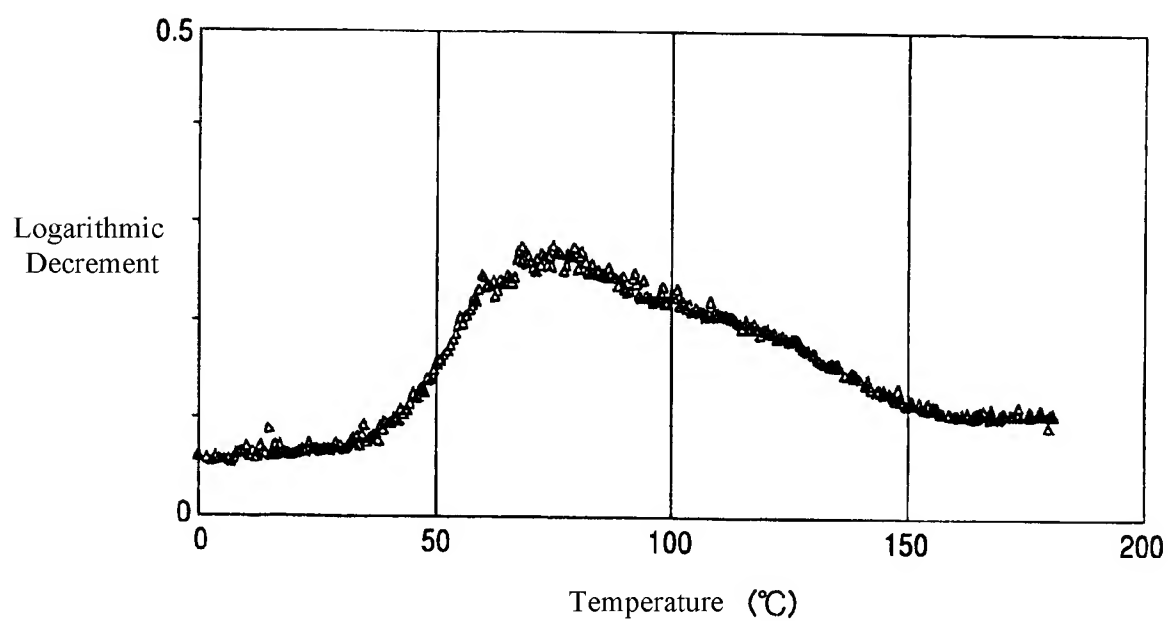


FIG. 7

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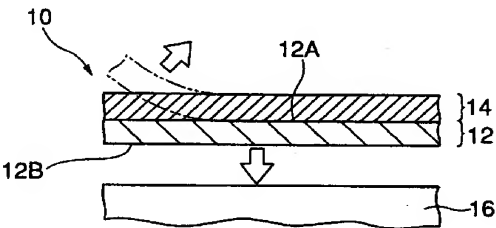
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权利要求书 2 页 说明书 14 页 附图 4 页

[54] 发明名称 液晶性复制体及其制造方法  
[57] 摘要

液晶性复制体 10 有在支撑体 14 表面形成的液晶层 12，位于此液晶层 12 的支撑体 14 一侧的剥离面 12A 附近的表面硬度高于在液晶层 12 的靠被复制体 16 一侧的粘合面 12B 附近的表面硬度。由此，液晶层 12 的粘合面 12B 与被复制体 16 的粘合力比剥离面 12A 与支撑体 14 的密合力大，使得液晶层 12 可以确实没有部分残留在支撑体 14 上那样来被复制到被复制体 16 上。





1. 一种液晶复制体，其特征在于它备有支撑体以及在所述支撑体的表面上形成的、位于所述支撑体的反面一侧的粘合面上可与被复制体粘合而且可以从位于所述支撑体侧的剥离面剥离的液晶层，并其所述液晶层中的表面硬度在所述粘合面附近比在所述剥离面附近低。

2. 权利要求项 1 所述的液晶性复制体，其特征在于其所述液晶层是由可聚合的液晶分子构成且所述液晶层中在所述粘合面附近的液晶分子残余双键率比所述剥离面附近高。

3. 权利要求项 2 所述的液晶性复制体，其特征在于所述液晶层中所述剥离面附近的液晶分子残余双键率为所述粘合面附近的 60% 以下。

4. 权利要求项 1 所述液晶性复制体，其特征在于所述液晶层为依次层积的多个薄液晶层所构成。

5. 权利要求项 4 所述的液晶性复制体，其特征在于所述各薄液晶层是由可聚合的液晶分子构成，且所述多个薄液晶层中在所述粘合面附近的薄液晶层的液晶分子残余双键率比所述剥离面附近的薄液晶层高。

6. 权利要求项 5 所述的液晶性复制体，其特征在于形成剥离面的薄液晶层中的液晶分子残余双键率为在形成所述粘合面的薄液晶层中的液晶分子残余双键率的 60% 以下。

7. 权利要求项 1 至 6 中的任一项所述的液晶性复制体，其特征在于所述液晶层中的液晶分子是胆固醇相的。

8. 权利要求项 1 至 6 中的任一项所述的液晶性复制体，其特征在于所述支撑体是拉伸膜。

9. 权利要求项 1 至 6 中的任一项所述的液晶性复制体，其特征在于在所述支撑体中与所述液晶层的所述剥离面相接触的面上已经形成了取向膜。

10. 一种液晶性复制体的制造方法，其特征在于在备有支撑体以及在所述支撑体的表面上形成的、位于所述支撑体的反面一侧的粘合面上可与被复制体粘合而且可以从位于所述支撑体侧的剥离面剥离的液晶层的液晶复制体的制造方法中，包括了在支撑体的表面形成由射线照射而聚合的液晶分子所构成的液晶层的工序和，在空气气氛下用

射线照射所述液晶层而使所述液晶层在所述粘合面附近的液晶层的表面硬度比所述剥离面附近的液晶层的表面硬度小那样固化的工序。

11. 权利要求项 10 所述的液晶性复制体的制造方法，其特征在于所述空气气氛是氧浓度在 0.5% 以上的气氛。

5 12. 一种液晶复制体的制造方法，其特征在于在备有支撑体以及在所述支撑体的表面上形成的由多个薄液晶层构成的、位于所述支撑体的反面一侧的粘合面上可与被复制体粘合而且可以从位于所述支撑体侧的剥离面剥离的液晶层的液晶性复制体的制造方法中，包括了在  
10 支撑体的表面形成由射线照射而聚合的液晶分子所构成的薄液晶层的工序、用射线照射所述薄液晶层使所述薄液晶层固化的工序、在固化了的所述薄液晶层表面形成由射线照射而聚合的液晶分子所构成的附加薄液晶层的工序、和用射线照射所述附加薄液晶层使所述附加薄液晶层固化的工序，并把所期望的层数的薄液晶层依次层积而形成所述  
15 附加薄液晶层的工序和固化工序重复 1 次以上、且通过使在由多个薄液晶层构成的液晶层中含有的各个薄液晶层的硬度为在所述粘合面附近比在所述剥离面附近低那样来控制所述各薄液晶层的固化状态。

13. 权利要求项 12 所述的液晶性复制体的制造方法，其特征在于它是通过用射线照射所述各薄液晶层时的气氛中的氧浓度来控制所述各薄液晶层的固化状态的。

20 14. 权利要求项 12 所述的液晶性复制体的制造方法，其特征在于它是通过照射所述各薄液晶层的射线的照射量来控制所述各薄液晶层的固化状态的。

15. 一种液晶性复制体的制造方法，其特征在于在备有支撑体以及在所述支撑体的表面上形成的由多个薄液晶层构成的、位于所述支撑体的反面一侧的粘合面上可与被复制体粘合而且可以从位于所述支撑体侧的剥离面剥离的液晶层的液晶复制体的制造方法中，包括了把  
25 由紫外线照射而聚合的液晶分子所构成的薄液晶层在支撑体的表面上按所期望的层数依次层积的工序、用紫外线照射层积了的所述薄液晶层使所述薄液晶层固化的工序、且由多个薄液晶层构成的液晶层中所  
30 含有的各薄液晶层的硬度是使在所述粘合面附近小于所述剥离面附近那样，由在所述各薄液晶层中加入的光引发剂的量来控制所述各薄液晶层的固化状态的。

## 液晶性复制体及其制造方法

## 技术领域

- 5 本发明涉及把具有偏光作用等光学功能的液晶层复制到被复制体上的液晶性复制体，尤其是涉及把在支撑体表面形成的液晶层从所述支撑体上剥离而复制到被复制体上的液晶性复制体及其制造方法。

## 背景技术

- 10 历来，在上述那样的液晶性复制体中，液晶层与支撑体之间设置有剥离层或易粘合层，可以从支撑体容易地把液晶层剥离，就可以把它复制到被复制体上了。

- 15 这里，为了把液晶层复制到被复制体上，就有必要使液晶层粘合于被复制体上。为了这样做，历来的方法一般是在液晶层和复制此液晶层的被复制体之间通过粘合层为中介的方法。还有，除了把粘合层预先设置在液晶层的复制面（与被复制体粘合的一侧面）一侧或被复制体一侧以外，已经在向被复制体复制的过程中设置液晶层的复制面或被复制体上设置粘合层。

- 20 再是，使液晶层粘合在被复制体上的其它方法还有由热压使液晶层粘合在被复制体上的方法。

- 25 不过，如上所述，对于在液晶层和支撑体之间设置了剥离层或易粘合层的液晶性复制体来说，层多使得结构变复杂了，还有，构成剥离层或易粘合层的物质混入了液晶层内，在剥离时就有部分附着在液晶层上，存在有所说的复制到被复制体上之后液晶层的光学特性下降的情况。

- 30 又及，在上述那样的液晶性复制体中，通过粘合层为中介把液晶层粘合到被复制体上，由于粘合层，就有所说的复制到被复制体上之后液晶层的光学特性下降的情况。作为此场合的光学特性下降的原因，列举的有在粘合层与液晶层和与被复制体之间的界面上发生的界面反射。又及，由于粘合层的流动性，在向例如极平坦的被复制体上复制时，粘合层的流动使厚度变得不均匀，降低了已粘合的液晶层的平整性。

再是，要把粘合层制成  $1\mu\text{m}$  以下的薄层是困难的，由于它有一定的厚度，带色、剥离、以及如在特开平 8-313729、特开平 11-29325、特开平 8-75924、特开平 11-151877 等中已经揭示的那样，加热而变黄者较多。特别是，如特开 2000-28827 所揭示那样，在由丙烯酸树脂构成的粘合层的场合，超过  $200^{\circ}\text{C}$  的高温就变黄，这是都知道的内容。

进一步说，在如上述那样的液晶性复制体中，即使是由热压使液晶层粘合在被复制体上，在上述那样的没有剥离层和易粘合层、粘合层的情况下，液晶层与支撑体一起被热压而紧密粘合在被复制体上之后，在从液晶层剥离支撑体时，就有着所说的不容易剥离支撑体的情况。

这里，由于支撑体以及被复制体的材料，就发生了被复制的液晶层与支撑体之间的密合力比此液晶层与被复制体的密合力大的问题。在这样的场合，液晶层复制到被复制体上之后，把支撑体从液晶层剥离时支撑体就不易被剥离。特别是，在液晶层非常薄的情况下，就有剥破的问题。更有，例如在特开平 11-311710 中所揭示的那样，在胆固醇型液晶层上热压上了其它的胆固醇型液晶层，但是即使这样，胆固醇型液晶层仍很薄，与胆固醇型液晶层相互的密合力相比，胆固醇型液晶层与支撑体的密合力更大，这使得胆固醇型液晶层向被复制体的复制变得困难，就有胆固醇型液晶层破损(被破坏)的情况。

#### 发明揭示的内容

本发明在考虑了这些点以后，提供了即使不用剥离层和易粘合层、粘合层等也可以使在不损及液晶层的情况下确实而且容易的把液晶层复制到被复制体上的液晶性复制体及其制造方法。

本发明的第一特征是，提供了一种液晶性复制体，其特征在于它备有支撑体和 在所述支撑体表面上形成的，在位于所述支撑体的反面的粘合面可以与被复制体粘合而且可以从位于所述支撑体侧的剥离面剥离的液晶层，所述液晶层的表面硬度在所述粘合面附近要比所述剥离面附近低。

再是，在与本发明的第 1 特征有关的液晶性复制体中，所述液晶层是由可聚合液晶分子所构成，以在所述液晶层中所述粘合面附近的液晶分子的残余双键率比所述剥离面附近高为优选。还有，在所述液

晶层中，在所述剥离面附近的液晶分子残余双键率为所述粘合面附近的60%以下为优选。

又有，在与本发明的第1特征有关的液晶性复制体中，所述液晶层优选由依次层积的多个薄液晶层所构成。还有，所述各薄液晶层是由可聚合的液晶分子所构成，在所述多个薄液晶层中液晶分子的残余双键率在所述粘合面附近的薄液晶层比在所述剥离面附近的薄液晶层高为优选。还有，以在形成所述剥离面的薄液晶层中液晶分子的残余双键率为在形成所述粘合面的薄液晶层中的液晶分子残余双键率的60%以下为优选。

更有，在与本发明的第1特征有关的液晶性复制体中，所述液晶层中的液晶分子以是胆固醇相为优选。还有，所述支撑体以是拉伸膜为优选。更是，在所述支撑体中，与所述液晶层的所述剥离面相接触的面上形成了取向膜者为优选。

本发明的第2特征是，提供了一种液晶性复制体的制造方法，其特征在于在备有支撑体和在其所述支撑体表面上形成的、在位于所述支撑体的反面的粘合面可以与被复制体粘合，而且可以从位于所述支撑体侧的剥离面剥离的液晶层的复制体制造方法中，包括了在支撑体的表面用射线照射而形成由聚合了的液晶分子构成的液晶层的工序、在空气气氛下用射线照射所述液晶层以使所述液晶层中的表面硬度变成在所述粘合面附近比所述剥离面附近低那样来使所述液晶层固化的工序。

再是，在与本发明的第2特征有关的液晶性复制体的制造方法中，所述空气气氛以是氧浓度在0.5%以上的气氛为优选。

本发明的第3特征是，提供了一种液晶性复制体的制造方法，其特征在于在备有支撑体和在其所述支撑体表面上形成的多个薄液晶层构成的液晶层、在位于所述支撑体的反面的粘合面可以与被复制体粘合、而且可以从位于所述支撑体侧的剥离面剥离的液晶层的复制体的制造方法中，包括了在支撑体的表面用射线照射而形成由聚合了的液晶分子构成的薄液晶层的工序、用射线照射所述薄液晶层使所述薄液晶层固化的工序、在固化了的所述薄液晶层的表面上形成由射线的照射而聚合了的液晶分子构成的附加薄液晶层的工序、用射线照射所述附加薄液晶层使所述附加薄液晶层固化的工序，如层积所期望的层积

层数的薄液晶层那样依次层积，重复进行所述形成附加薄液晶层工序和固化工序 1 次以上，以使在由多个薄液晶层所构成的液晶层中所含的各薄液晶层的硬度在所述粘合面附近要比所述剥离面附近低那样来控制所述各薄液晶层的固化状态。

- 5 再是，在与本发明的第 3 特征有关的液晶性复制体的制造方法中，优选通过在使用射线对所述各薄液晶层照射时的气氛中的氧浓度来控制所述各薄液晶层的固化状态。又有，优选以由照射所述各薄液晶层的射线的照射量来控制所述各薄液晶层的固化状态。

- 10 本发明的第 4 特征是，提供了一种液晶性复制体的制造方法，其特征在于在备有支撑体和在其所述支撑体表面上形成的多个薄液晶层构成的液晶层、在位于所述支撑体的反面的粘合面可以与被复制体粘合、而且可以从位于所述支撑体侧的剥离面剥离的液晶层的液晶性复制体的制造方法中，包括了在支撑体的表面依次层积由用紫外线照射而聚合了的液晶分子构成的薄液晶层到所期望层数的工序、用紫外线  
15 照射层积了的所述多个薄液晶层使所述薄液晶层固化的工序、以使在由多个薄液晶层所构成的液晶层中所含的各薄液晶层的硬度在所述粘合面附近要比所述剥离面附近低那样，由在所述各薄液晶层中所加入的光聚合引发剂的量来控制所述各薄液晶层的固化状态。

- 20 根据本发明，调整液晶层中的在支撑体一侧的剥离面附近以及在被复制体一侧的粘合面附近的表面硬度，由于液晶层的粘合面与被复制体的粘合力要比剥离面与支撑体的粘合力大，在液晶层确实与被复制体紧密粘着的同时，就可以容易的把支撑体从液晶层上剥离。为此，即使不用剥离层与易粘合层、粘合层等，就可以确实没有使液晶层破损而造成液晶层的部分液晶成分残留在支撑体上，而且可以容易的把  
25 液晶层复制到复制体上。

还有，根据本发明，由于没有必要在液晶性复制体的液晶层和支撑体之间设置剥离层或易粘合层，使层的构成单纯，而且构成剥离层或易粘合层的物质已经混入了液晶层内，在剥离时不会有一部分附着在液晶层上。

- 30 更是，根据本发明，由于没有必要在液晶性复制体的液晶层与被复制体之间以粘合层为中介，使得界面数变少，这就不会有由界面反射导致的液晶层光学特性下降，由于液晶层直接密合在被复制体上，

即使在被复制体的平整性高的场合仍可维持其平整性，不会使光学特性下降。还有，不会发生由粘合层引起的色度的变化、剥离、因加热变黄等。

## 5 附图的简单说明

图 1 是放大的与本发明的第 1 实施形态相关的液晶性复制体的截面概图；

图 2 是说明图 1 所示的液晶性复制体的制造方法的截面概图；

10 图 3 是放大的与本发明的第 2 实施形态相关的液晶性复制体的截面概图；

图 4 是说明图 3 所示的液晶性复制体的制造方法的截面概图；

图 5 是说明图 3 所示的液晶性复制体的另一制造方法的截面概图；

15 图 6 是表示与本发明的一个实施例有关的液晶性复制体中与被复制体的粘合面的对数衰减率-温度关系曲线；

图 7 是表示比较例的液晶性复制体中与被复制体的粘合面的对数衰减率-温度关系曲线。

## 实施发明的最佳形态

20 下面参照附图来说明本发明的实施形态。

### 第 1 实施形态

首先由图 1 和图 2 来说明本发明的第 1 实施形态。

25 如图 1 所示，与本发明的第 1 实施形态有关的液晶性复制体 10 是在由例如拉伸 PET (聚对苯二甲酸乙二酯) 膜构成的支撑体 14 的表面上形成的液晶层 12。这里，液晶层 12 可以由位于支撑体 14 的反面的粘合面 12B 与被复制体 16 粘合，而且，可以从位于支撑体 14 一侧的剥离面 12A 上剥离。再是，液晶层 12 的从支撑体 14 剥离一侧的剥离面 12A 附近的表面硬度比在粘合到被复制体 16 一侧的粘合面 12B 附近的表面硬度高。

30 液晶层 12 是由与由拉伸 PET 膜构成的支撑体 14 接触而取向的光聚合型液晶 (例如胆固醇型液晶) 所形成，如后面所述，由调整固化条件，使得剥离面 12A 一侧和粘合面 12B 一侧的表面硬度有如上述那样



的不同。再是，液晶层 12 除了可以用由紫外线等照射而聚合的液晶分子(液晶性单体或液晶性低聚物)之外，还可以用高分子液晶。

再是，这里所说的“液晶层”意指已经保持有具有液晶性质(特别是光学特性)部分的膜，而并不是指物理意义上所说的液晶相。例如，  
5 即使没有流动性，但如果是保持有液晶相(例如胆固醇相)分子排列的固化膜，也成了这里所说的液晶层。

其次，参照图 2 来说明在图 1 所示的液晶性复制体 10 的制造方法(使液晶层 12 中剥离面 12A 附近部分和粘合面 12B 附近部分的表面硬度不同的方法)。这里，以使用由紫外线照射聚合的胆固醇型液晶单体  
10 来形成液晶层 12 的情况为例。

首先，准备好添加有光聚合引发剂的胆固醇型液晶单体溶液，把它按图 2(A)中符号 11 所示那样涂布在由拉伸 PET 膜构成的支撑体 14 的表面上之后，经干燥除去溶剂，形成如图 2(B)所示那样的未固化液晶层 11A。

接着，如图 2(B)所示，在空气气氛(氧浓度约 20%)下从液晶层  
15 11A 侧用紫外线照射此未固化的液晶层 11A 和支撑体 14，使液晶层 11A 固化。由此，如图 2(C)所示，就可以制作备有固化了的液晶层 12 的液晶性复制体 10。

这里，液晶层 12 的粘合面 12B 一侧暴露于空气中，由紫外线的照射抑制了液晶分子的 C=C 键(例如胆固醇型液晶分子有的丙烯基中的碳原子之间的双键等)的断裂，而由于剥离面 12A 一侧与氧不接触而进行固化。因此，在液晶层 12，粘合面 12B 附近的表面硬度变为比在剥离面 12A 附近的表面硬度低。  
20

为此，如图 1 所示，在把液晶层 12 复制到被复制体 16 时，液晶层 12 的粘合面 12B 与被复制体 16 的密合力比剥离面 12A 和支撑体 14 的密合力大，液晶层 12 就处于与被复制体 16 粘合的状态，也就容易从液晶层 12 把支撑体 14 剥离。  
25

这里，液晶层 12 的表面硬度(表面固化度)可以由在剥离面 12A 和粘合面 12B 附近的液晶分子(这里说的“液晶分子”是指单分子、低聚物、高分子以及有反应性 C=C 键的液晶性化合物的全部)的残余双键  
30 率来确认。

再是，所谓“残余双键率”定义为：



[液晶分子中的  $C=C$  键吸收( $810\text{cm}^{-1}$  附近)的光谱强度] $\div$ [液晶分子中的芳香环吸收( $1500\text{cm}^{-1}$  附近)的光谱强度]。

由这样定义的残余双键率直接表示了在聚合反应中未反应的双键( $C=C$ )以什么样的比例存在,故反应率(聚合率)用 $[(1-(\text{残余双键率}))]$

5 来表示。

再是,如上所述,液晶层 12 的表面硬度在粘合面 12B 附近要比剥离面 12A 附近低,这使液晶层 12 中的液晶分子的残余双键率在粘合面 12B 附近要比剥离面 12A 附近高。再是,在用液晶分子的残余双键率来表示时,液晶层 12 的剥离面 12A 附近与粘合面 12B 附近的表面硬度之比以其剥离面 12A 一侧的残余双键率为相对于粘合面 12B 一侧的残余双键率的 60% 以下为好。

还有,在用紫外线照射来使液晶层 11A 固化的场合,氧浓度过低就不能产生液晶层 12 的剥离面 12A 一侧和粘合面 12B 一侧的反应率差,因此优选空气气氛中的氧浓度在 0.5% 以上。

15 再有,把紫外线变成电子线等射线来照射也是可以的,不过,在这种场合,在涂布于支撑体 14 的表面的胆固醇型液晶单体溶液中以不加入光聚合引发剂为好。

根据与本发明的第 1 实施形态有关的液晶性复制体 10,调整液晶层 12 中的支撑体 14 一侧的剥离面 12A 附近和被复制体 16 一侧的粘合面 12B 附近的表面硬度,使液晶层 12 的粘合面 12B 与被复制体 16 的粘合力比剥离面 12A 与支撑体 14 的粘合力大,在使液晶层 12 确实与被复制体 16 密合的同时,可以容易的从液晶层 12 把支撑体 14 剥离。由此,即使不用剥离层和易粘合层、粘合层等,就可以在确实没有使液晶层 12 破损而造成液晶层 12 的部分液晶成分残留在支撑体 14 上,而且可以容易的把液晶层 12 复制到被复制体 16 上。

## 第 2 实施形态

下面由图 3 和图 4 来说明与本发明第 2 实施形态相关的液晶性复制体。除了本发明的第 2 实施形态的液晶层是由多个薄液晶层构成这一点之外,其它都与上述第 1 实施形态大体相同。在本发明的第 2 实施形态中,与上述第 1 实施形态相同的部分用同样的符号,其详细说明就略去了。

如图 3 所示,与本发明的第 2 实施形态有关的液晶性复制体 20 是在例如拉伸 PET(聚对苯二甲酸乙二酯)膜所构成的支撑体 14 的表面上形成的、依次层积的 2 层(或 3 层以上)的薄液晶层 24A、24B 所构成的液晶层 22。这里,液晶层 22 可以由位于支撑体 14 反面的粘合面 22B 与 5 与被复制体 16 粘合而且可以从位于支撑体 14 一侧的剥离面 22A 剥离。还有,在液晶层 22 中,形成从支撑体 14 剥离一侧的剥离面 22A 的薄液晶层 24A 的硬度比形成与被复制体 16 粘合一侧的粘合面 22B 的薄液晶层 24B 的硬度高。再是,两者的硬度比,与和上述第 1 实施形态相关的液晶性复制体 10 的液晶层 12 中的情况一样,在薄液晶层 10 24A、24B 为可聚合液晶分子构成时,是由各薄液晶层 24A、24B 中液晶分子的残余双键率之比所决定的,例如,在剥离面 22A 一侧的薄液晶层 24 中的液晶分子残余双键率变为在粘合面 22B 一侧的薄液晶层 24B 中的液晶分子残余双键率的 60% 以下为好。

下面参照图 4 来说明图 3 所示的液晶性复制体 20 的制造方法。再是,这里是用由紫外线照射聚合的胆固醇型液晶单体来形成液晶层 22 15 的情况为例来说明的。

首先,准备好加有光聚合引发剂的胆固醇型液晶单体的溶液,把它如图 4(A)的符号 21A 所示那样涂布在与上述第 1 实施形态同样的拉伸 PET 膜构成的支撑体 14 的表面上之后,经干燥除去溶剂,形成了如图 20 图 4(B)所示的未固化的薄液晶层 23A。

接着,如图 4(B)所示,在氮气气氛(氧浓度 0.5% 以下)下用紫外线照射此未固化的薄液晶层 23A,使薄液晶层 23A 固化。由此,如图 4(C)所示,形成了固化的薄液晶层 24A。

其后,如图 4(D)所示,在固化的薄液晶层 24A 的表面上,涂布上 25 以符号 21B 表示的、与前述一样的胆固醇型液晶单体的溶液,按同样次序,形成了如图 4(E)所示的未固化薄液晶层 23B。

然后,如图 4(E)所示,在空气气氛(氧浓度 0.5% 以上)下,用紫外线照射此未固化的薄液晶层 23B,使薄液晶层 23B 固化。由此,如图 4(F)所示,形成固化了的薄液晶层 24B,最后,就可以制作备有固化 30 了的薄液晶层 24A、24B 层积所构成的液晶层 22 的液晶性复制体 20。

再是,在 3 层以上的多层构成的情况下,反复进行与上述同样的工序(图 4(D) ~ (F)),依次层积成所期望的层积数的薄液晶层。

这里,由以拉伸PET膜所构成的支撑体14的取向力使薄液晶层24A取向,另一方面,薄液晶层24B由与取向状态下的固化了的薄液晶层24A的直接接触而取向。

又有,由于薄液晶层24B是在空气气氛下固化的,相对于氮气气氛下固化的薄液晶层24A,薄液晶层24B的固化度低。即,液晶层22中,形成从支撑体14剥离一侧的剥离面22A的薄液晶层24A的硬度要比形成与被复制体16粘合一侧的粘合面22B的薄液晶层24B的硬度大,由此,薄液晶层24B与被复制体16的粘合力要比薄液晶层24A与支撑体14的粘合力大。

再是,如上所述,薄液晶层24A、24B的固化状态可以由用紫外线照射各薄液晶层24A、24B时的气氛中氧浓度的高低来控制,此外,还可以由光聚合引发剂的加入量、紫外线的照射量或它们的组合来控制。

在由光聚合引发剂的加入量来控制薄液晶层24A、24B的固化状态时,如图5所示,预先把未固化的多个薄液晶层23A、23B依次层积后(图5(A)、(B)),用紫外线照射此层积的多个薄液晶层23A、23B一次,就可以制作备有由固化了的薄液晶层24A、24B层积所构成的液晶层22的液晶性复制体20。

在由气氛中的氧浓度的高低和紫外线等的照射量来控制薄液晶层24A、24B的固化状态时,也可以使用电子线等射线来代替紫外线。在此场合,涂布于支撑体14表面的胆固醇型液晶单体溶液中不加入光聚合引发剂也行。

如果用与本发明的第2实施形态有关的液晶性复制体20时,调整液晶层22中形成支撑体14一侧的剥离面22A的薄液晶层24A的硬度和形成被复制体16一侧的粘合面22B的薄液晶层24B的硬度,使得液晶层22的粘合面22B与被复制体16的粘合力比剥离面22A与支撑体14的粘合力大,在多个薄液晶层24A、24B构成的液晶层22确实与被复制体16密合的同时,就很容易从液晶层22把支撑体14剥离、为此,即使不用剥离层和易粘合层、粘合层等,就可以在确实没有使液晶层22破损而且容易地把液晶层22复制到被复制体16上。

再,在上述第1和第2实施形态中是从此液晶层侧用紫外线照射于支撑体14表面所形成的液晶层的,不过,本发明并不限于此,在紫

5 外线透过支撑体 14 或对紫外线的吸收少时，通过支撑体 14 为中介来照射也行。在此场合，通过对液晶层的厚度、光聚合引发剂、液晶本身的紫外线吸收、必要时的紫外线吸收材料的加入等的调整，使液晶层的剥离面一侧和粘合面一侧的紫外线照射量有 10: 6 程度的差异也行。

更有，在上述第 1 和第 2 实施形态中，作为形成液晶层 12、22 的液晶用的是有胆固醇相的液晶分子构成的胆固醇型液晶，不过，本发明并不限于此，也可以用手性向列液晶和向列液晶等其它的任意液晶。还有，支撑体 14 并不限于拉伸 PET 膜等拉伸膜，也可以使用其它的膜状基材。在此场合，如拉伸 PET 膜那样在基材表面没有取向力的场合，有必要在与液晶层 12、22 的剥离面 12A、22A 接触的面上形成取向膜。

再是，在上述第 1 和第 2 实施形态中，是以由紫外线照射而聚合的液晶分子(液晶性单体和液晶性低聚物)所构成的液晶层为例的，不过，本发明并不限于此，由高分子液晶所构成的液晶层也同样可以适用。在制造备有由高分子液晶构成的液晶层的液晶性复制体的场合，首先要将高分子液晶涂布在具有取向力的支撑体的表面，经干燥后，形成液晶层。接着，在这样形成的液晶层中的粘合面一侧喷上溶剂，来提高粘合面一侧表面的溶剂浓度以使其变柔软。由此，就可以制作液晶层的表面硬度在粘合面附近比剥离面附近小的液晶性复制体。

## 实施例

### (实施例 1)

25 首先，把向列液晶与手性剂混合，调整成呈分子螺旋结构(胆固醇相)的胆固醇型液晶单体的 33% 甲苯溶液(胆固醇型液晶溶液)。

接着，在此胆固醇型液晶溶液中，加入 5% 的光聚合引发剂，例如 Irg184、Irg369 或 Irg651(均是 Ciba 特殊化学品公司制造)。

30 然后，把这样的胆固醇型液晶溶液由旋涂法涂布在作为支撑体的厚度为 50 $\mu$ m 的拉伸 PET 膜的表面，在从常温(21 $^{\circ}$ C)到 80 $^{\circ}$ C 的温度范围干燥以除去溶剂，形成了厚度为 10 $\mu$ m 的未固化的胆固醇型液晶层。

在空气气氛(氧浓度约 20%)和温度 21 $^{\circ}$ C 下，用 20mJ/cm<sup>2</sup> 的紫外线从胆固醇型液晶层一侧照射此胆固醇型液晶层及支撑体，使胆固醇

型液晶层固化。由此，制作如图 1 所示的液晶性复制体。其中，作为照射紫外线的光源使用的是超高压汞灯，所记录的紫外线的强度是由 365nm 接收器所测定的值。

5 把这样制作的液晶性复制体，通过作为支撑体的拉伸 PET 膜的反面一侧的粘合面与作为被复制体的玻璃相接触那样贴合起来，在辊温 150℃、速度 0.5m/min、辊压 0.3MPa 的层压条件下用层压机热压。

10 然后，放热冷却到常温 (21℃) 之后，把支撑体拉伸 PET 膜剥离，支撑体拉伸 PET 膜很容易地从胆固醇型液晶层被剥离，使胆固醇型液晶层确实复制到玻璃上。再是，并没有部分胆固醇型液晶层残留在拉伸 PET 膜一侧，而且胆固醇型液晶层也没有破损。

### (实施例 2、3)

15 实施例 2、3 是与实施例 1 同样的条件，只是改变了胆固醇型液晶层的厚度。实施例 2 制作的是备有厚度 1μm 的胆固醇型液晶层的液晶复制体，实施例 3 制作的是备有厚度 5μm 的胆固醇型液晶层的液晶复制体。

把由这样制作的液晶性复制体以与实施例 1 同样的顺序与被复制体玻璃热压，就可以很好的把胆固醇型液晶层复制到玻璃上了。

### 20 (实施例 4)

25 把与实施例 1 同样的胆固醇型液晶溶液涂布在与实施例 1 同样的拉伸 PET 膜的表面上，形成未固化的胆固醇型液晶层，在氮气氛 (氧浓度 0.5% 以下)、温度 21℃ 下，从未固化的胆固醇型液晶层一侧照射 10mJ/cm<sup>2</sup> 的紫外线，使胆固醇型液晶层固化。由此，形成了第 1 薄液晶层。

接着，在此固化了的第 1 薄液晶层的表面上，按前面同样的顺序直接成膜形成同样的胆固醇型液晶层，在氮气氛 (氧浓度 0.5% 以下)、温度 21℃ 下，从未固化的胆固醇型液晶层一侧照射 0.4mJ/cm<sup>2</sup> 的紫外线，使胆固醇型液晶层固化。由此，形成了固化了的第 2 薄液晶层。  
30 最后，制作备有由固化了的第 1 和第 2 薄液晶层层积构成的胆固醇型液晶层的液晶性复制体。

这里，尽管在用紫外线照射第 1 和第 2 薄液晶层时的气氛是一样

的, 差别在于对第 1 薄液晶层的紫外线照射量为对第 2 薄液晶层的紫外线照射量的 20 倍以上。

把由这样制作的液晶性复制体在上述同样的层压条件下与玻璃热压, 冷却后剥离拉伸 PET 膜, 胆固醇型液晶层很好复制到玻璃上了, 第 1 薄液晶层没有部分残留在拉伸 PET 膜上, 第 1 或第 2 薄液晶层也没有破损。

#### (实施例 5)

在作为被复制体的玻璃上涂布上胆固醇型液晶溶液以形成固化的胆固醇型液晶膜。然后, 把实施例 1~4 所制作的各个液晶性复制体, 使液晶性复制体的胆固醇型液晶层与被复制体玻璃上的胆固醇型液晶膜相接触那样, 于辊温 150℃、速度 0.5m/min、辊压 0.3MPa 的层压条件下, 用层压机把它与如上面所述那样形成带有胆固醇型液晶膜的玻璃热压。

然后, 放热冷却到常温(21℃)之后, 把支撑体拉伸 PET 膜剥离, 所有的液晶复制体中, 支撑体拉伸 PET 膜很容易从胆固醇型液晶层剥离, 胆固醇型液晶层本身确实可以复制到作为被复制体的带胆固醇型液晶膜的玻璃一侧上了。

#### (比较例)

为了与实施例 1 制作的液晶性复制体相比较, 把与实施例 1 所用的同样胆固醇型液晶溶液涂布在与实施例 1 同样的拉伸 PET 膜的表面上, 形成未固化的胆固醇型液晶层, 在氮气氛(氧浓度 0.5%以下)、温度 21℃下, 对其照射 10mJ/cm<sup>2</sup> 的紫外线, 使胆固醇型液晶层固化。由此, 制作了作为比较例的液晶性复制体。

把这样制作的液晶性复制体在与实施例 1 同样的层压条件下复制到玻璃上, 结果不能完全复制。

再有, 表 1 示出了实施例 1 和比较例两方面测定的在此时支撑体(拉伸 PET 膜)-胆固醇型液晶层间以及胆固醇型液晶层-玻璃间的剥离强度的结果。

表 1

胆固醇型液晶性复制体	剥离强度 $10^{-3}\text{N/mm}$	
	支撑体-胆固醇型 液晶层间	胆固醇型 液晶层-玻璃间
实施例 1	2	12
比较例	2	2

由上面的表 1 可知，比较例的液晶复制体的剥离强度在支撑体-胆固醇型液晶层间以及胆固醇型液晶层-玻璃间是一样的，但实施例的液晶性复制体则大相庭径，胆固醇型液晶层-玻璃间的剥离强度大，即难以剥离，表示可以容易的复制到玻璃一侧上。

表 2 示出了实施例 1 和比较例各自的液晶性复制体中剥离面附近与粘合面附近的液晶分子反应率(聚合率)的测定结果。(此反应率与在胆固醇型液晶层的剥离面和粘合面附近的液晶分子的固化度成比例。)

表 2

胆固醇型液晶性 复制体	实施例 1		比较例	
	被复制 一侧	支撑体 一侧	被复制 一侧	支撑体 一侧
胆固醇液晶分子 的反应率	1.6	2.7	2.6	2.6

此测定是用红外光谱确认在胆固醇型液晶层测定面的厚度方向上的  $2 \sim 3\mu\text{m}$  范围内的  $\text{C}=\text{C}$  键的反应率。

胆固醇型液晶分子具有丙烯基，在紫外线照射下， $\text{C}=\text{C}$  键断裂，进行反应而固化。

由上述表 2 可知，比较例的液晶性复制体的剥离面一侧和粘合面一侧的液晶分子反应率(即固化度)几乎没有差别，但在实施例 1 中，在粘合面一侧的液晶分子反应率是剥离面一侧的液晶分子反应率的 59%。

还有，图 6 和图 7 分别示出了用刚体振子试验器(A&D 公司制造)对实施例 1 和比较例的各自的液晶性复制体的与被复制体密合的面(粘

合面)的表面状态解析结果。

图 6 和图 7 示出了作为表示所测定表面的硬度的指标之一的对数衰减率与温度变化的关系,对数衰减率越大则越柔软,粘着性高。

由图 6 和图 7 可知,与比较例 1 的液晶性复制体相比,实施例 1 的液晶性复制体对被复制体的密合力大,液晶分子中的残余双键率也比比较例的液晶性复制体大。

还有,比较图 6 和图 7 可知,在实施例 1 的液晶性复制体中,低温侧的对数衰减率明显大。这表示,即使在低温下,胆固醇型液晶层的表面也存在有具有流动性的成分,在宽温度范围内具有流动性,使得向被复制体复制时容易解消膜的畸变,引出了提高密合性的效果。这里,所说的有流动性成分是指未固化胆固醇型液晶分子、单体或分子量较小的低聚物。



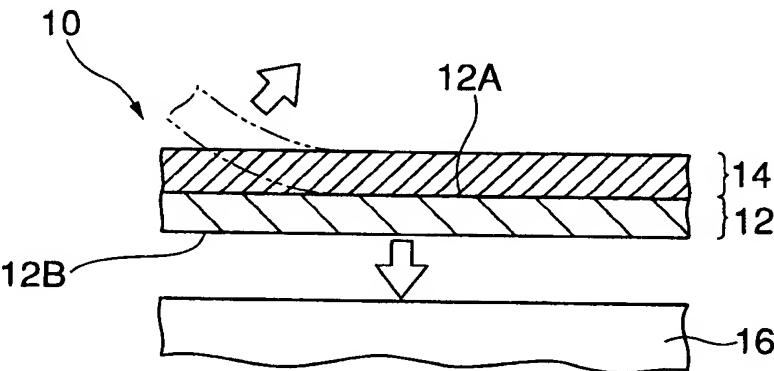


图 1

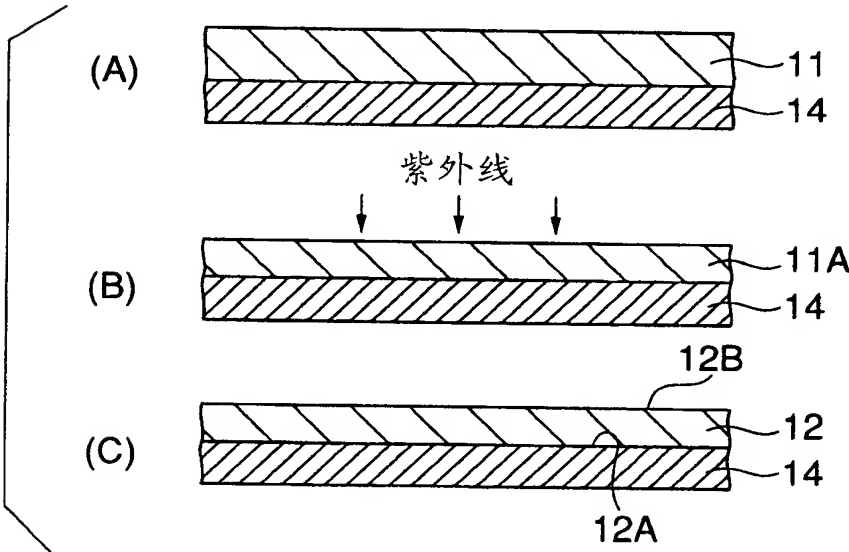


图 2

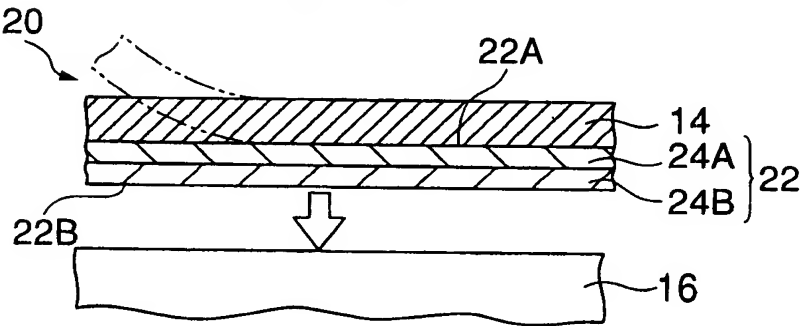


图 3

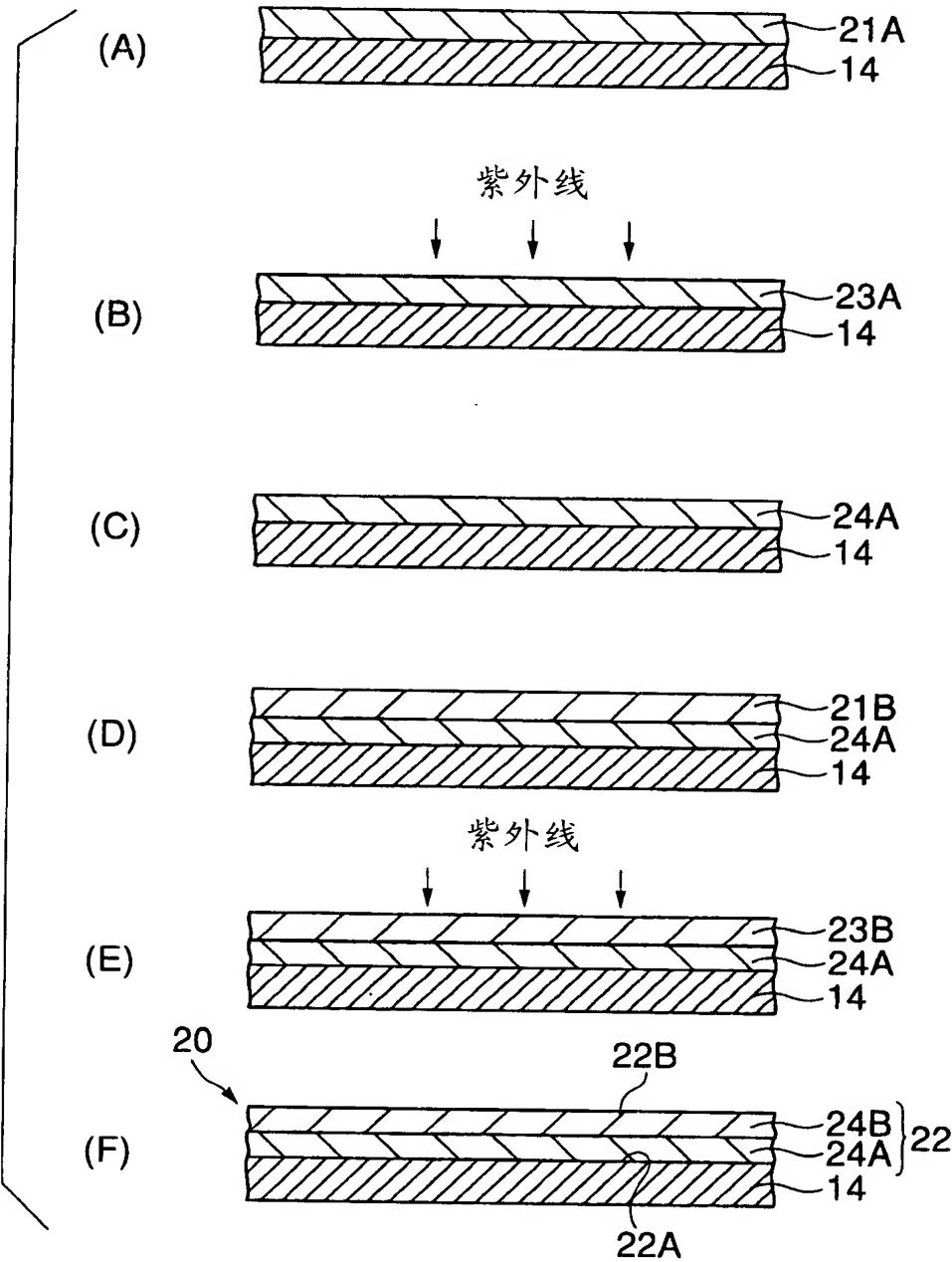


图 4

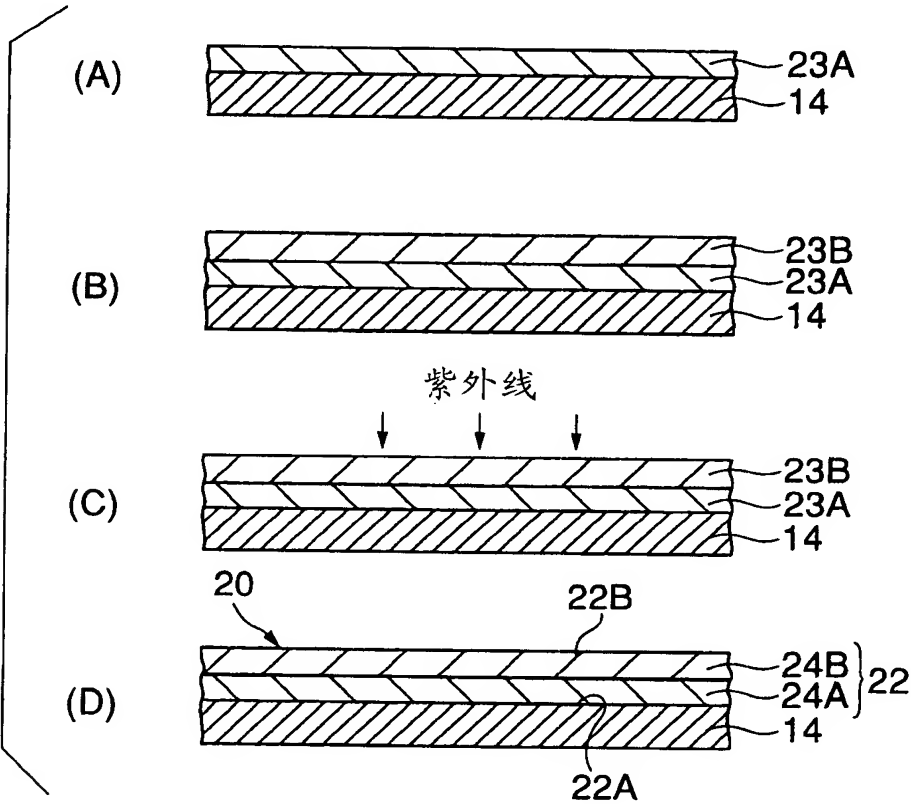


图 5

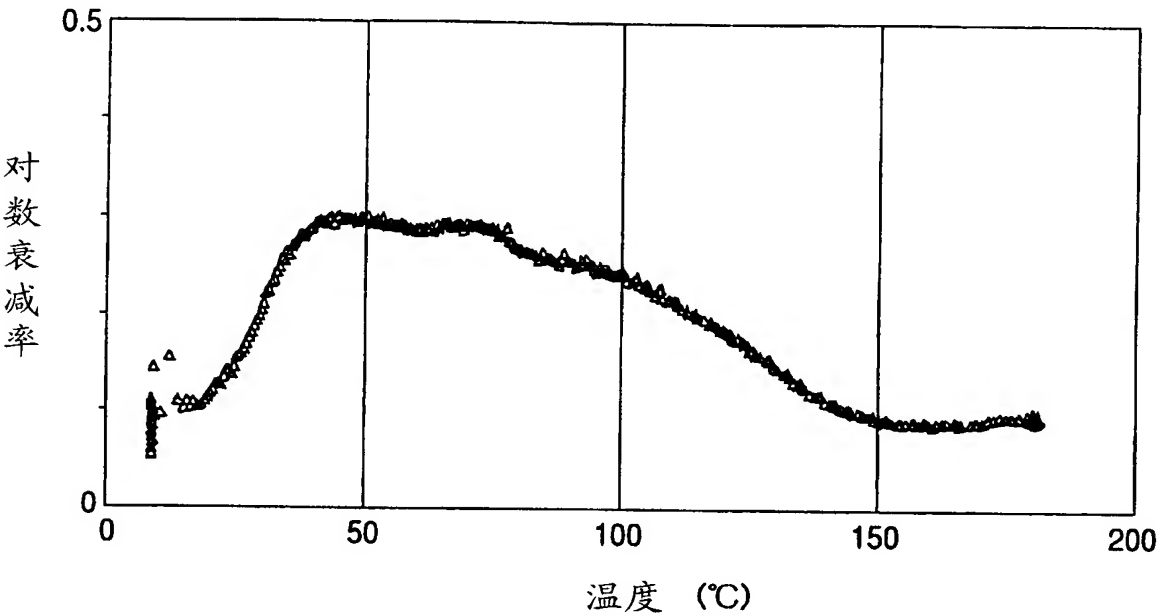


图 6

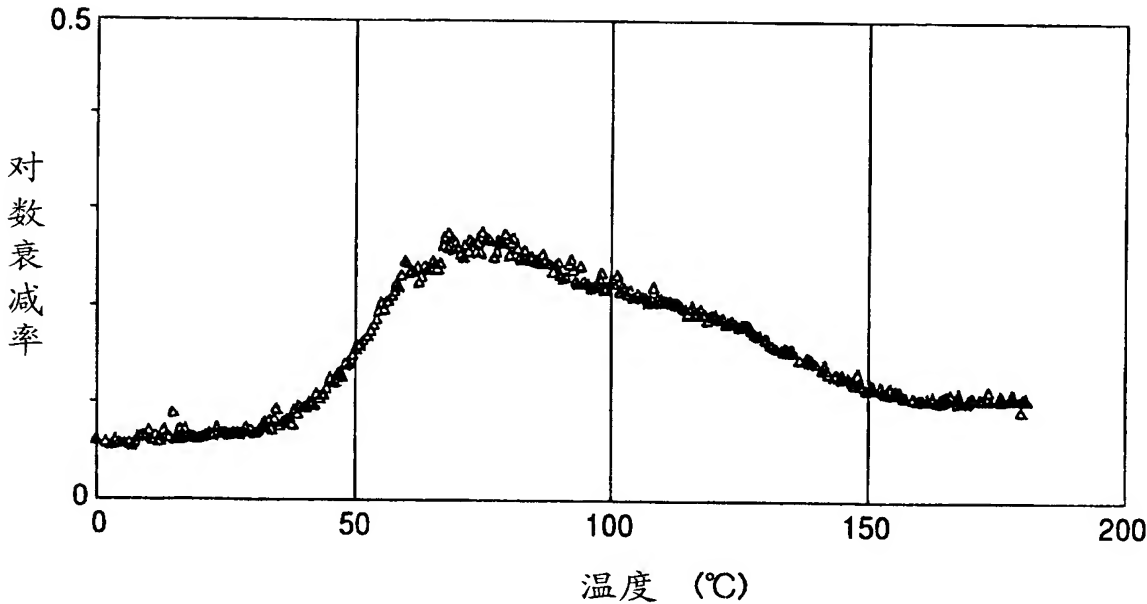


图 7